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

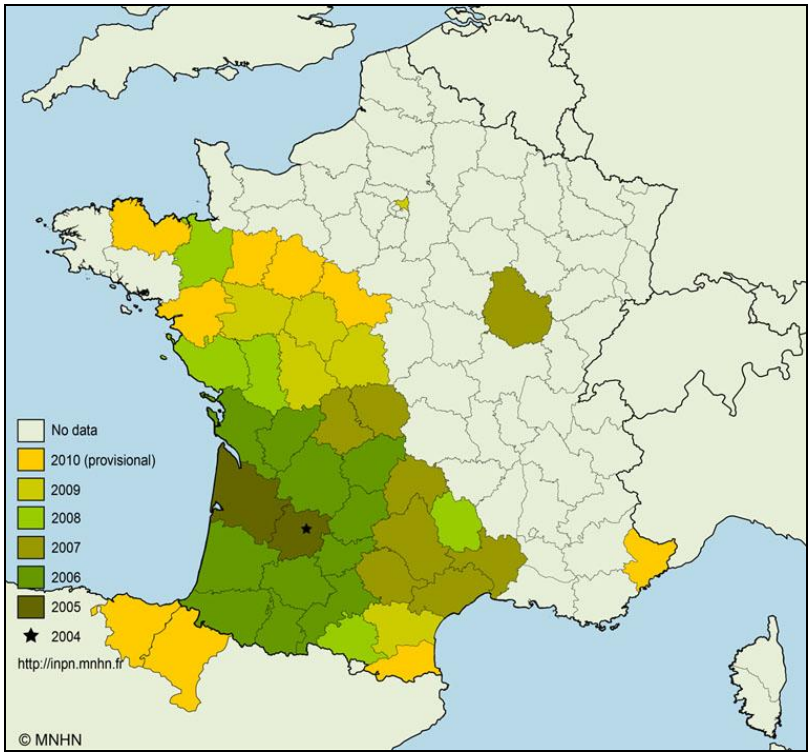
For more information visit: www.nonnativespecies.org

Name of Organism:	***Vespa velutina nigrithorax*, The Asian hornet**
Objectives:	Assess the risks associated with this species.
Version:	Original draft 25/07/11
Author:	Prepared by Gay Marris[1], Mike Brown[1] and Andrew G. Cuthbertson[2] [1.] National Bee Unit, Fera [2.] Crop and Food Security, Fera
Suggested citation:	Marris *et al* (2011). GB Non-native Organism Risk Assessment for *Vespa velutina nigrithorax*. www.nonnativespecies.org

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 - 4	Low - 0	1. Natural spread of pest itself by flight. 2. Movement of wood, wood products and bark (which provide suitable harbourages for hibernating inseminated *V. velutina* queens). 3. Movement of man-made goods that provide suitable harbourages for hibernating inseminated *V. velutina* queens (e.g. ceramic pottery associated with garden trade). 4. Movement of soil associated with plant trade (harbourage for hibernating inseminated *V. velutina* queens; potentially nesting stages in soil). 5. Fruit imports (e.g. grapes) (could transport adult *V. velutina* using fruit as food source). 6. Movement on freight containers and transport vehicles themselves (harbourages for hibernating inseminated *V.*

			velutina queens; could also carry worker hornets). 7. Movement of honey bees: queens and packaged bees (workers) for the purposes of trade (could transport adult *V. velutina*). Of the above seven pathways, no.s 1. and 2. (natural spread by the pest itself and transport of hibernating queens with e.g. comparatively large trees with bark) are considered to be of relatively high importance; pathway no.s 3. and 5. (with other (man-made) hibernation sites, or on fruit/cut flowers) are considered to be of intermediate importance; pathway no.s 4., and 6. (movement on soil or on freight/other transport vehicles) are considered to be of comparatively low importance; pathway 7. (movement with traded honey bees) is included for sake of completeness, but is considered to be least likely of all seven.
1.2 Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	**Pathway 1. Natural spread of pest itself by flight.**		
1.3 How likely is the organism to be associated with the pathway at origin?	Very likely – 4	Low – 0	The current (2010 provisional) European range of the Asian hornet is illustrated below (Map courtesy of Claire Villemant, Muséum National d'Histoire Naturelle, Paris, France (MNHN)). *Vespa velutina* is present (2010 estimate) in at least 39 départements of France (Villemant *et al*., 2011a), and was confirmed in North East Spain for the first time in November 2010 (Castro & Pagola-Carte, 2010) in Irun, Hondarribia and Oiartzun. Current researchers predict that many countries in Europe including the UK are climatically suitable for establishment of *V. velutina* (Rome *et al.*, 2009; Villemant *et al*., 2011b) and spread within France and into Spain has been very rapid (Villemant *et al*., 2011a). Asian hornets have been present in Brittany since 2008 – this region immediately abuts Basse Normandie, the coast of which is comparatively closer to southern England.



The shortest distance between England and France over the English Channel is 34km, between Dover and Cap Gris Nez. *V. velutina* is present in at least one coastal area of France (Northern Brittany: Ille-et-Vilaine since 2008; Côte-d'Armor, since 2010) In the (highly likely) event that *V. velutina* increases its European range, and also spreads to other more northerly coastal regions of France, then in theory inseminated Asian hornet queens could fly across the Channel. (Asian hornet workers could also travel by this Pathway, but these do not pose a threat of establishment in the Risk Assessment area, as they are incapable of establishing new colonies). (ii) Distances covered by adult *V. velutina* in single flights are unknown, but unpublished data on *V. velutina*'s flight

			capacity in the laboratory suggests that males can fly dozens of km in one flight, and workers several km. Queens are believed to be even more efficient flyers but have not been tested yet (pers. comms. Marc Kenis, CABI Switzerland). (iii) Research into flight capacity of Asian hornet queens is ongoing (*pers. comm*. Quentin Rome, MNHN) - It is possible that certain weather conditions (wind direction) will assist natural spread (*pers. comm*. Claire Villemant MNHN).. (iv) There are no confirmed records of other social Hymenoptera crossing from continental EU to the UK via this Pathway, but the Median wasp, *Dolichovespula media*, a non-native species established in the UK since 1980, was first recorded in the coastal area of East Sussex (Falk, 1982), implying that it flew across the Channel from mainland Europe. (v) There are numerous records of other insects (butterflies, ladybirds etc.) crossing the English Channel each year, sometimes in vast numbers: (http://www.nationalinsectweek.co.uk/facts.php)
1.4 Is the concentration of the organism on the pathway at origin likely to be high?	Moderately likely – 2	Low – 0	(i) *V. velutina* is present in at least one coastal area of France (Northern Brittany: Ille-et-Vilaine since 2008; Côte-d'Armor, since 2010) , and is highly likely to reach other coastal areas in the near future (potentially in 2011). (ii) The concentration of *V. velutina* on the Pathway at origin will depend on the size of the hornet population in any given area - as many as ten *V. velutina* nests have been reported in a radius of just 600m (Villemant & Haxaire, 2007) (iii) Records of hornet species forming swarms are rare, but swarms of the European hornet *V. crabro* may contain several thousand individual queens (Mulhauser & Vernier, 1994) – group migrations, although rare, do occur in the native hornet, and may occur in *V. velutina*. (iv) An account of an attack by *V. velutina* in France described the hornets as originating from a "single swarm" (Bond, 2009), but frequency of swarming behaviour in Asian hornets is unknown. It is unlikely that a swarm of hornets could cross the channel in a single flight. (iv)

1.5 How likely is the organism to survive existing cultivation or commercial practices?	N/A		No cultivation or commercial practices associated with this Pathway.
1.6 How likely is the organism to survive or remain undetected by existing measures?	N/A		No detection measures specifically associated with this Pathway.
1.7 How likely is the organism to survive during transport/storage?	Likely – 2	Low – 0	(i) There is no data available on the likelihood that *V. velutina* queens could survive a non-stop flight over a distance of 34km (minimum distance across English Channel). However, there are numerous examples of other insects crossing the Channel by their own means (see 1.3 above, and http://www.nationalinsectweek.co.uk/facts.php (ii) The Median wasp, *Dolichovespula media*, a non-native species established in the UK since 1980, was first recorded in the coastal area of East Sussex (Falk, 1982), implying that it arrived from Europe having flown across the channel. (iii) Under normal circumstances, the lifespan of an adult female *V. velutina* is 24-142 days, and an adult male 4-60 days (Dong & Wang, 1989), but this assumes access to food, water and shelter.
1.8 How likely is the organism to multiply/increase in prevalence during transport /storage?	Very unlikely – 0	Low – 0	Conditions during cross-Channel flight completely incompatible with multiplication. Prevalence would be more likely to decrease, due to individual hornets dying during the journey (adverse weather, exhaustion etc.).
1.9 What is the volume of movement along the pathway?	Very low – 0	Low – 0	Unknown. Likely to be low.
1.10 How frequent is movement along the pathway?	Very infrequent – 0	Low – 0	Unknown. Likely to be low.
1.11 How widely could the organism be distributed throughout the Risk Assessment area?	Limited distribution – 1	Low – 0	Cross-Channel entry into the UK via natural spread would mean that *V. velutina* would initially be most likely to arrive in southern England.
1.12 How likely is the organism to arrive during the months of the year most appropriate for establishment ?	Very likely – 4	Low – 0	(i) The active months for *V. velutina* are between April and November, the peak being August/September (Abrol, 1994; HaiQin *et al*., 2006; Mollet *et al*., 2006; 2007; Chauzat & Martin, 2009) – so adult Asian hornets would be most likely

			to arrive during these months via this Pathway. (ii) Establishment in the Risk Assessment area via this Pathway can only occur if the hornet in question is an inseminated queen – only this life stage can found a new colony. (iii) Inseminated queens arriving early in the season (spring) could establish new nests. (iv) Inseminated queens arriving in the autumn could overwinter in the UK. (v) Irrespective of the date of arrival, worker hornets would not be expected to establish in the Risk Assessment area – this life stage is not capable of reproducing, and is also dependent on a colony of co-workers for survival.
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		No commodities associated with this Pathway.
1.14 How likely is the organism to be able to transfer from the pathway to a suitable habitat?	Very likely – 4	Low – 0	(i) Adult workers: The length of time which an Asian hornet worker can survive away from her colony is unknown – an individual arriving in the Risk Assessment area via this Pathway would only be expected to survive in the short term, depending on access to food and shelter, but she would not be capable of independent existence long term - this life stage is also dependent on a colony of co-workers for survival. (ii) Queen hornets are highly mobile, and very adaptable – they are unlikely to have to travel far from the Pathway to locate suitable habitats. As long as they have access to water, nesting material (wood), and food – their needs will be met - Food must provide a source of carbohydrate for founder queens (e.g. fruit/nectar) and source of prey (which does not have to be honey bees, but can be other locally available insects) for developing hornet larvae (Matsuura & Yamane, 1990; Perrard *et al*., 2009) - all resources to meet *V. velutina*'s basic requirements are widespread throughout the UK, including areas associated with this Pathway (Southern coastal regions).

1.2 Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	**Pathway 2. Importation of wood and wood products (provide suitable harbourages for hibernating inseminated *V. velutina* queens).**		
1.3 How likely is the organism to be associated with the pathway at origin?	Likely - 3	Medium - 1	The native geographic range of *Vespa velutina* includes Bangladesh, Bhutan, China (including Hong Kong), India, Indonesia (Java, Sumatra, Sulawesi), Korea Republic, Laos, Malaysia, Myanmar, Thailand and Vietnam. This distribution is illustrated in the map below. Asian hornets are now present in France and northern Spain (see map in Pathway 1., response 1.3, above).  Map of Asian range of *Vespa velutina* The UK imports a wide variety of commodities from these EU and non-EU countries where *V. velutina* is known to be

			present. Inseminated queens of *V. velutina* search for small, well-insulated crevices in which to hibernate. Each individual has the potential to found an entire new colony. *V. velutina* queens have been found hibernating underneath tree bark (Dong & Wang, 1989; Villemant & Haxaire, 2007; Chauzat & Martin, 2009). There is an extremely broad range of tree species and wood products (e.g. timber, wooden crates etc.) that offer potentially suitable hibernation sites of this type. A variety of trees, wood and wood products are imported into the UK, and some of these come from countries where *V. velutina* is known to be present. This Pathway has multiple origins. It is not possible to be specific about likelihood of *V. velutina* queens associating with any particular tree species, in any given country – *V. velutina*'s preferences for particular tree species are unrecorded.
1.4 Is the concentration of the organism on the pathway at origin likely to be high?	Unlikely - 1	Low - 0	Hibernating adult *V. velutina* can cluster in small groups of up to 3 individuals (Mollet *et al*., 2006; 2007; Chauzat & Martin, 2009), although size of congregations may vary depending on the commodity in question. A relatively small crevice could harbour several individuals. Several overwintering Asian hornet queens were found in a single oak tree, in cavities left by beetle larvae (Mollet *et al*., 2006; 2007). The concentration of *V. velutina* on the Pathway at origin will also depend on the size of the hornet population in any given area - as many as ten *V. velutina* nests have been reported in a radius of just 600m (Villemant & Haxaire, 2007) – this is a higher nest concentration than observed for native European hornet *V. crabro* (Larsson, 1988).
1.5 How likely is the organism to survive existing cultivation or commercial practices?	Moderately - 2	Low - 0	Likelihood of survival depends on growing and felling conditions, whether or not the tree species is controlled (see Question 1.6, below), its country of origin (EU *v*. 3rd country), and the type of wood product: (i) It is highly unlikely that *V. velutina* would survive processes of bark removal or wood-

			chipping; (ii) It is probable that *V. velutina* would not survive processes such as wood-treatment with preservatives or stains; (iii) It is entirely possible that *V. velutina* would survive in untreated fuel-wood/logs; (iv) *V. velutina* queens seeking refuge in wood after it has been processed (e.g. a pile of chipboard, wooden packing crates etc.), would be expected to survive; (v) Some (but not all) imported wood and wood products are treated to eradicate tree pests. e.g. kiln-drying, fumigation or heat treatment (56^{o}C, 30 minutes) (see response to Question 1.6 below). It is likely that kiln-drying would be lethal to *V. velutina* adults, as it is used to effectively control a variety of tree pests, including bark beetles (Forestry Commission, 2007). Asian hornets will die at a temperature of 45^{o}C, as demonstrated by the natural and lethal "heat-balling" defense response of *A. ceranae* (Ono *et al*., 1995; Ken *et al*., 2005; Chauzat & Martin, 2009); (vi) Uncontrolled timber imports may not be treated, allowing *V. velutina* to survive; (vii) in cases where whole living trees are harvested (e.g. olive trees for garden trade), *V. velutina* would be expected to survive.
1.6 How likely is the organism to survive or remain undetected by existing measures?	Likely - 3	Low - 0	Import regulations and potential detection measures depend on tree species, country of origin and nature of wood product. These are summarised in Forestry Commission Plant Health Guide *Importing wood, wood products and bark* (Forestry Commission, 2007) and also Plant Health Directorate 2000/29/EC. <u>Wood imports from third countries</u>: Tree genera originating from relevant third countries (i.e. those within the Asian hornet's range), which are currently prohibited under EU legislation include all conifers, sweet chestnuts and citrus trees. (It is anticipated that in 2010 import of *Acer* from China will also banned). Some other species are permitted, but only under specified conditions (e.g. that the tree is dormant, and not in leaf). Examples of this type include

			certain oaks and poplars. However, under existing legislation (Plant Health Directive 2000/29/EC), the majority of tree species can be imported into the Risk Assessment area. Relevant wood materials and products (i.e. those that could provide suitable hibernation niches for *V. velutina* queens) of controlled tree species include: fuel wood in logs; isolated tree bark; wood waste and scrap; wood "in the rough" (treated or otherwise) with bark still on; railway sleepers; wooden packing cases, boxes, crates, drums, pallets etc.; casks, barrels, vats and tubs; prefabricated buildings of wood. These products can be imported into the UK if they are certified as meeting at least one of the following requirements: bark-free, kiln-dried to <20% moisture content, subjected to an approved fumigation regime, or heat-treated to a minimum core temperature of 56^{o}C for at least 30 minutes. Plant health checks of controlled imports from third countries are made at approved points of entry into Great Britain (see www.forestry.gov.uk/planthealth). These include airports, docks etc. In a typical year 1,000,000m^3 of controlled timber goods originating from third countries are officially inspected, corresponding to 5,000 separate plant health checks. Inspectors check paperwork to ensure that certification of above treatments is in order, and physically examine consignments, to ensure freedom from tree pests (Forestry Commission, 2007). If landing requirements are not met, the inspector can prohibit landing, order re-export of the consignment, or destruction of the consignment (by burning). **Key points**: (i) The fact that above controlled commodities lack bark and/or must be treated prior to entry greatly reduces the probability that *V. velutina* will survive existing management practices imposed on third country wood imports; (ii) Only a proportion of any consignment (a representative sample) of controlled wood/wood products from a third country may be inspected, and *V. velutina* is **not** a tree pest; if present in any numbers these hornets are likely to

			be detected, but they are not specifically targeted during plant health inspections; (iii) Many trees/wood products from third countries are not subject to control, and will not be inspected/treated as above – *V. velutina* could enter undetected through such Pathways. <u>Wood imports from EU:</u> These are subject to far fewer restrictions and checks. Controls focus solely on conifers and sweet chestnut. To ensure freedom from certain listed tree pests (but not *V. velutina*), these must be bark-free or kiln dried. Alternatively, they can enter the EU with bark and without having been treated, as long as they come with a statement that they originate from an area free of named tree pests. When controlled woods/wood products originate within the EU, they are not inspected at approved points of entry, and are able to travel to their destination unchecked as long as they have appropriate documentation. Wood importers must register as Forestry Traders, and it is their responsibility to check that importation requirements are met. **Key points**: (i) *V. velutina* is **not** a quarantine tree pest or disease; if present in any numbers these hornets may be detected at final destination, but they are not specifically targeted during inspections of controlled wood products entering from the EU. (ii) the vast majority of wood entering from the EU is not subject to any control, and will not be inspected – for example, importation of large mature olive trees from continental Europe (including France and Spain), complete with bark, is completely legal and unregulated. Such trees do not require a plant passport and can move freely from France and Spain to the UK without inspection. Mature olive trees imported from EU can be purchased from many garden centres throughout the UK.
1.7 How likely is the organism to survive during transport/storage?	Very likely - 4	Low - 0	Specific data re. duration of Asian hornet hibernation under natural circumstances is limited, but it typically lasts about 4 months (Dong & Wang, 1989) – far longer than the typical duration of transportation for wood imports. Length of

			storage for any commodity depends on goods involved.
1.8 How likely is the organism to multiply/increase in prevalence during transport /storage?	Very unlikely - 0	Low – 0	Hibernating queens of *V. velutina* are dormant – not in physiological state at which multiplication will occur.
1.9 What is the volume of movement along the pathway?	High - 4	Low - 0	A large proportion of the wood and wood products consumed in the UK are imported, from a range of different countries. (Information on imports can be obtained from the Overseas Trade Statistics compiled by HM Revenue and Customs). In a typical year, the UK imports approx 50 million m^3 of raw wood material equivalent (WRME) underbark. The majority of this arrives as coniferous sawnwood, paper/paperboard (e.g. in form of packaging materials), or as wood-based panels. 17% of the UK's plywood imports come from Indonesia and China (*V. velutina* present); 27% of imported particle- board comes from France (all figures Forestry Commission, 2005). In the UK: almost 90% of softwood used in construction is imported; 70% of softwood pallets use imported wood; approximately 20% of fencing/outdoor softwood is imported (Moore, 2009). Volume of trade in living mature trees from *V. velutina*'s current range (especially France and Spain) is unknown.
1.10 How frequent is movement along the pathway?	Very frequent – 4	Low – 0	Movement of wood, wood products and bark into the Risk Assesment area occurs throughout the year.
1.11 How widely could the organism be distributed throughout the Risk Assessment area?	Very widely – 4	Low – 0	Controlled wood and wood products from third countries must arrive through approved points of entry into Great Britain (see www.forestry.gov.uk/planthealth). These include over 70 ports and airports across England. Uncontrolled wood imports from third countries, and all wood imports from the EU can travel directly to their destination – potentially anywhere in Risk Assessment area.
1.12 How likely is the organism to arrive during the months of the year most appropriate for establishment ?	Very likely – 4	Low – 0	Wood and wooden commodities may potentially be brought in at any time, including months most suitable for establishment. Risk greatest with imports in spring – just prior to completion of hibernation and emergence of queens ready to found new colonies.

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?	Moderately likely – 2	Medium – 1	Depends on the type of wood/wood product - Certain commodities (e.g. olive trees) will be placed out doors, straight into a suitable habitat for *V. velutina* (i.e. garden). Timber intended for outdoor use will also aid transfer – the UK imports a large volume of softwood for use in fencing (see response to Question 1.9, above).
1.14 How likely is the organism to be able to transfer from the pathway to a suitable habitat?	Moderately likely – 2	Low – 0	(i) Depends on the type of commodity imported and where it will be used – e.g. indoors *versus* outdoors. Transfer will be much more likely if goods are placed outside and the hornets are not confined on emergence. (ii) The majority of inspections of controlled wood/wood products entering the UK from third countries are made in the open, "at the quayside" (Ian Brownlee, Forestry Commission, pers. comm., 2010); this fact could impact on likelihood of escape of adult *V. velutina*. (iii) Storage conditions of wood and wood products post-inspection will depend on their intended use. (iv) Provided a mated queen remains undisturbed long enough to complete hibernation (i.e. wood commodity in which she is concealed is not processed, but stored), then she can emerge to found a new colony. Queen hornets are highly mobile, but are unlikely to have to travel far from the Pathway to locate suitable habitats. (See Pathway 1. Question 1.14). *V. velutina* is also very adaptable - all of this hornet species' basic requirements are widespread throughout the UK, including areas associated with this Pathway. (v) The distribution of the native European hornet *V. crabro* within the Risk Assessment area is largely confined to England south of Yorkshire and Wales (Edwards, 1997) – assuming requirements of *V. velutina* are similar, then likelihood of transfer to a suitable habitat from this pathway will be greatest within these areas.
1.2 Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	**Pathway 3. Movement of man-made goods that provide suitable harbourages for hibernating inseminated *V. velutina* queens (e.g. ceramic pottery associated with garden trade).**		
1.3 How likely is the organism to be associated with the pathway at origin?	Unlikely	High – 2	Inseminated queens of *V. velutina* do not just use "wild" sites in which to hibernate; they will also use man-made sites as

			long as these provide small, well-insulated refuges in which they can hide away over the winter months (Dong & Wang, 1989; Villemant & Haxaire, 2007; Chauzat & Martin, 2009). The range of commodities that are suitable hibernation sites is extremely broad, so is not possible to be specific about likely concentration of *V. velutina* at the potentially multiple origins of this Pathway. It is believed that hibernating queens of *V. velutina* were imported into France from Yunnan (China) in ceramic bonsai pots (Villemant *el al*., 2006a) (see response to Question 1.29, below).
1.4 Is the concentration of the organism on the pathway at origin likely to be high?	Unlikely	Medium - 1	Hibernating adult *V. velutina* can cluster in small groups of up to 3 individuals (Mollet *et al*., 2006; 2007; Chauzat & Martin, 2009), although size of congregations may vary depending on the commodity in question. A relatively small volume crevice could harbour several individuals, each mated queen having the potential to establish an entire new hornet colony. Since the range of commodities suitable for hibernation (any dark, well-insulated, dry substrate) is extremely broad, it is not possible to be specific about likely concentration of *V. velutina* at the potentially multiple origins of this Pathway.
1.5 How likely is the organism to survive existing cultivation or commercial practices?	Likely – 1	High – 2	This Pathway has multiple origins, and is likely to have a range of different commercial practices associated with it. It is therefore impossible to anticipate chances of *V. velutina* surviving in each case. However, the case of introduction of *V. velutina* into France demonstrates that the Asian hornet survived the Pathway of importation on ceramic pottery (see response to Question 1.3, above).
1.6 How likely is the organism to survive or remain undetected by existing measures?	Likely - 1	Medium - 1	This Pathway involves a wide range of commodities, likely to be subjected to a correspondingly diverse array of different inspection procedures. It is unknown whether ceramic pottery imported from EU or third countries into the Risk Assessment area are routinely inspected. However, the case of introduction of *V. velutina* into France demonstrates that the Asian hornet was not detected on this commodity (see response to Question 1.3, above). It is possible for ceramic

			garden goods to be imported from France, Spain or elsewhere in mainland Europe to the UK without any inspection that would reveal hibernating *V. velutina*.
1.7 How likely is the organism to survive during transport/storage?	Likely – 2	Low - 0	The example of introduction of *V. velutina* into France on (presumably untreated) ceramic pottery demonstrates its ability to survive during transport/storage. Specific data re. duration of Asian hornet hibernation under natural circumstances is limited, but it typically lasts about 4 months (Dong & Wang, 1989) – far longer than typical duration of transportation for most imports. Length of storage for any commodity depends on goods involved.
1.8 How likely is the organism to multiply/increase in prevalence during transport /storage?	N/A		Hibernating queens of *V. velutina* are dormant – not in physiological state at which multiplication will occur.
1.9 What is the volume of movement along the pathway?	High - 2	Low - 0	Since the range of commodities suitable for hibernation (any dark, well-insulated, dry substrate) is extremely broad, it is not possible to be specific about volume of movement along this Pathway. However, numerous suitable commodities (in terms of hibernation refuge sites offered) are imported into the UK in bulk every year.
1.10 How frequent is movement along the pathway?	Frequent -2	Low - 0	This Pathway has multiple origins. It is not possible to be specific about frequency of movement. However, numerous suitable commodities (in terms of hibernation refuge sites offered) are imported into the UK in bulk throughout the year.
1.11 How widely could the organism be distributed throughout the Risk Assessment area?	Very widely – 4	Low – 0	This Pathway has potential to introduce *V. velutina* throughout the Risk Assessment area: anywhere imported goods containing live hibernating Asian hornet queens are placed.
1.12 How likely is the organism to arrive during the months of the year most appropriate for establishment ?	Very likely – 4	Low – 0	Commodities may potentially be brought in at any time, including months most suitable for establishment.
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?	Moderately – 1	High – 2	Certain commodities (e.g. plant pots) may be placed out doors, assisting transfer. Others may be entirely for indoor use, or for processing – i.e. end-use entirely incompatible with aiding transfer,

1.14 How likely is the organism to be able to transfer from the pathway to a suitable habitat?	Likely - 2	High – 2	(i) Depends on the type of commodity imported and where it will be used – e.g. indoors *versus* outdoors – transfer will be much more likely if goods are placed outside and the hornets are not confined on emergence. (ii) Provided a mated queen remains undisturbed long enough to complete hibernation, then she can emerge to found a new colony. (iii) Queen hornets are highly mobile, and very adaptable – they are unlikely to have to travel far from the Pathway to locate suitable habitats. (See Pathway 1. response to Question 1.14) - all resources to meet *V. velutina*'s basic requirements are widespread throughout the UK, including areas associated with this Pathway. (iv) The distribution of the native European hornet *V. crabro* within the Risk Assessment area is largely confined to England south of Yorkshire and Wales (Edwards, 1997) – assuming requirements of *V. velutina* are similar, then likelihood of transfer to a suitable habitat from this pathway will be greatest within these areas.
1.2 Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	**Pathway 4. Movement of soil associated with plant trade from third countries other than Mediterranean countries. Soil from the EU and Mediterranean countries.**		
1.3 How likely is the organism to be associated with the pathway at origin?	Moderately likely – 2	Low - 0	Hibernating mated queens of *V. velutina* have been recorded as overwintering in soil or leaf litter (Dong & Wang, 1989; Villemant & Haxaire, 2007; Builles, 2008). In addition, the Asian hornet will sometimes form nests underground (Dong & Wang, 1989; Martin, 1995; Villement & Haxaire, 2007). There is thus potential to import nesting *V. velutina* (larvae and pupae), and/or hibernating adult queens, with soil associated with plant trade from countries where these wasps are present. Plant imports are unlikely to come from nurseries particularly associated with beehives (preferred food source of *V. velutina*). i.e. likelihood of association with Pathway reduced, but otherwise unknown.
1.4 Is the concentration of the organism on the pathway at origin likely to be high?	Unlikely – 1	Low - 0	Volume of soil imported depends on the size of the plants in question – whatever is essential to sustain the vitality of the

			plants varies. Hibernating adult *V. velutina* can cluster in small groups of up to 3 individuals (Mollet *et al*., 2006; 2007; Chauzat & Martin, 2009), although size of congregations in soil is unknown: a relatively small volume of soil could harbour several individuals, each mated queen having the potential to establish an entire new hornet colony. By contrast, a very large volume of soil would be needed to conceal even part of a living hornet's nest. The concentration of *V. velutina* on the Pathway at origin will also depend on the size of the hornet population in any given area - as many as ten *V. velutina* nests have been reported in a radius of just 600m (Villemant & Haxaire, 2007) – this is a higher nest concentration than observed for native European hornet *V. crabro* (Larsson, 1988).
1.5 How likely is the organism to survive existing cultivation or commercial practices?	Moderately likely – 2	Medium - 1	Cultivation practices depend on the plant species in question. Heat treatment and fumigation of soil (required for imports from third countries) is likely to kill hibernating hornet queens. Likelihood of survival depends on the nature of the import in question.
1.6 How likely is the organism to survive or remain undetected by existing measures?	Moderately likely – 2	Low – 0	Nesting life stages. It is highly unlikely that even part of an active hornet's nest could be dug up without detection – such a disturbance would elicit an immediate, conspicuous and aggressive response from adult wasps (see response to Question 2.13). This means that nesting *V. velutina* are unlikely to be unnoticed if associated with any plants intended for export to UK. Hibernating queens of *V. velutina* would be much more discrete, and could potentially escape visual inspection. Current legislation regarding soil importation is as follows: (i) Third country imports: Soil and growing media containing soil is prohibited from third countries outside continental Europe, other than from Egypt, Israel, Libya, Morocco and Tunisia (Plant Health Directive 2000/29/EC, 2009). The exception to this is soil intended to sustain the vitality of the plants. In these cases there is a requirement for documentation that the growing medium is free from insects

			and harmful nematodes, and has been subjected to appropriate examination, heat treatment or fumigation and that appropriate measures have been taken to ensure it has been maintained free from harmful organisms (Plant Health Directive 2000/29/EC, 2009). Plant material from third countries (including those where Asian hornets are native) will be inspected on entry into the UK, although it is not possible to inspect every plant. Inspections could potentially pick up *V. velutina*, but there is no guarantee. Soil associated with plants can be difficult to inspect. However where heat treatment or fumigation is used, this is likely to kill *V. velutina*. (ii) EU imports: There are no restrictions on the movement of soil within the EU (or from Egypt, Israel, Libya, Morocco and Tunisia). Soil associated with plants imported from France and Spain where *V. velutina* is present) will not be inspected.
1.7 How likely is the organism to survive during transport/storage?	Very likely – 4	Low - 0	(i) Immature, nesting *V. velutina* would not be expected to survive: A living hornets nest requires regular feeding, cleaning, ventilation etc. (Perrard *et al*., 2009); all activities that must be supplied by free-living, foraging colony members which are able to fly to and from the nest. Such conditions would be impossible within this Pathway. (ii) Hibernating queens are highly likely to survive transport/storage. Asian hornet hibernation typically lasts about 4 months (Dong & Wang, 1989).
1.8 How likely is the organism to multiply/increase in prevalence during transport /storage?	Very unlikely – 0	Low – 0	(i) Any immature nesting life-stages of *V. velutina* imported with soil are likely to starve and die during transport/storage. Colony growth in absence of a queen *V. velutin*a and attendant workers is impossible. (ii) Hibernating queens of *V. velutina* are dormant – i.e. not in physiological state at which multiplication will occur.
1.9 What is the volume of movement along the pathway?	Moderately high – 2	Medium – 1	The volume of soil imported from third countries where *V. velutina* is present is unknown; the volumes of soil imports associated with plants from France and Spain are unknown. However, plants and associated soil are imported into the UK

			from mainland EU in bulk throughout the year
1.10 How frequent is movement along the pathway?	Moderately frequent – 2	Low - 0	The frequency of soil imports from third countries where *V. velutina* is present is unknown; the frequency of soil imports associated with plants from France and Spain are unknown. However, plants and associated soil are imported into the UK from mainland EU at all times of the year throughout the year
1.11 How widely could the organism be distributed throughout the Risk Assessment area?	Very widely – 4	Low – 0	This Pathway has potential to introduce *V. velutina* throughout the Risk Assessment area: e.g. any garden centre importing plants with soil that may contain live hibernating Asian hornet queens.
1.12 How likely is the organism to arrive during the months of the year most appropriate for establishment ?	Very likely – 4	Low – 0	Soil may potentially be brought in at any time, including months most suitable for establishment.
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?	Likely – 3	Low – 0	Plants may be planted out doors, assisting transfer.
1.14 How likely is the organism to be able to transfer from the pathway to a suitable habitat?	Moderately likely – 2	Low – 0	(i) Depends on the type of plants that have been imported and where they will be planted – in nurseries or outside, in areas where bee pollinators are regularly used etc. (ii) Provided a mated queen remains undisturbed long enough to complete hibernation (i.e. soil in which she is concealed is not processed), then she can emerge to found a new colony. (iii) Mated hornet queens are highly mobile and very adaptable – they are unlikely to have to travel far from the Pathway to locate suitable habitats (see Pathway 1 response to Question 1.14) - all resources to meet *V. velutina*'s basic requirements are widespread throughout the UK, including areas associated with this Pathway. (iv) The distribution of the native European hornet *V. crabro* within the Risk Assessment area is largely confined to England south of Yorkshire and Wales (Edwards, 1997) – assuming requirements of *V. velutina* are similar, then likelihood of transfer to a suitable habitat from this pathway will be greatest within these areas.

1.2 Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	**Pathway 5. Fruit/cut flower imports.**		
1.3 How likely is the organism to be associated with the pathway at origin?	Likely – 3	Low - 0	(i) Adult *V. velutina* utilise various fruits and flowers as sources of sugar, and have been recorded as feeding on apples, plums, grapes and Angelica (Mollet *et al*., 2006; 2007; Villemant & Haxaire, 2007; Builles, 2008). Like other hornets, they are positively attracted to very ripe fruit (Chang, 1968; Lim *et al*., 1989; Mishra *et al*., 1989; Shah & Shah, 1991). There is thus the potential for the Asian hornet to enter the Risk Assessment area with fruits/flowers imported from its known geographical range. (ii) Worker hornets and queens will use fruit as food. Both could be associated with this Pathway, but only queens pose risk of establishment. (iii) There are no records of *V. velutina* queens being spread by this Pathway. However, there are eight separate records of the Oriental hornet *V. orientalis* being intercepted on fruit and plant produce imported into the UK (data from Plant Health Interception Records, Fera). (iv) Although at time of interception it was not recorded whether or not these individuals were workers or queens, for the purposes of this Risk Assessment, measurements of the preserved specimens found all of them to exceed 25mm in length (i.e. all were within size range of queens) – dissection to confirm this was not possible due to condition of samples. (v) Most records are not specific about the type(s) of fruit/flower with which the Oriental wasps were associated, interceptions occurring at importers offices, market stalls etc. where a wide variety of produce is likely to be found.
1.4 Is the concentration of the organism on the pathway at origin likely to be high?	Very unlikely –0	Medium – 1	(i) Large numbers of *V. velutina* are not expected to be associated with this Pathway. (ii) However, 2 individuals of the Oriental hornet were detected in a single interception, (on imported *Ruscus* cuttings) (Data from Plant Health Interception Records, Fera). (iii) It is likely that relatively more hornets would associate with this Pathway in the

			autumn. Adult hornets cannot digest animal prey directly, but give this to their larvae which then produce carbohydrate and amino acid rich secretions on which the adults feed (Matsuura & Yamane, 1990). As the colony declines at the end of the season, workers must seek out other sources of sweet food elsewhere (Chauzat & Martin, 2009). For these reasons *V. velutina* is especially attracted to ripe fruit at the end of the summer (Mollet *et al*., 2006; 2007). (iv) The concentration of *V. velutina* on the Pathway at origin will also depend on the size of the hornet population in any given fruit growing area - as many as ten *V. velutina* nests have been reported in a radius of just 600m (Villemant & Haxaire, 2007) – this is a higher nest concentration than observed for native European hornet *V. crabro* (Larsson, 1988).
1.5 How likely is the organism to survive existing cultivation or commercial practices?	Likely – 3	Low - 0	(i) Fruit may be chilled during transport. In theory, this alone would not necessarily kill adult wasps, but the survival statistics for *V. velutina* at extreme temperatures have not been documented. (ii) Ripening chemicals or insecticides applied to fruits may affect survival, but it is unknown how often and on what fruit-commodities these would be used. (iii) Regarding records of the import of *V. orientalis* via this Pathway, at least 4 of the 9 hornets recovered were alive at time of interception. The fact that *V. orientalis* was able to survive existing commercial/cultivation practices indicates that *V. velutina* would be likely to do the same.
1.6 How likely is the organism to survive or remain undetected by existing measures?	Moderately likely – 2	Low - 0	(i) Imports from third countries: Some fruit imported from third countries is controlled, and must be accompanied by a phytosanitary certificate which states that the material in question has been officially inspected at point of origin, complies with statutory requirements for entry into the EU, is free from quarantine pests and diseases, and is "substantially free from other harmful organisms". Controlled fruits and flowers will be inspected (a representative sample of each consignment) by the Plant Health and Seeds Inspectorate (PHSI), and since live hornets are comparatively large and

			conspicuous in their behaviour, if present in large numbers *V. velutina* might be detected. However, since *V. velutina* is not a listed plant health quarantine pest (Directive EC/2000/29), this species is not specifically targeted during inspections. Other produce entering the UK from third countries, which is not considered to present a significant risk in terms of quarantine pests and diseases, is unrestricted and not subject to routine plant health controls. *V. velutina* could thus enter on these fruit/cut flower imports from third countries undetected. (ii) Imports from EU: The majority of fruit and flower imports from the EU are uncontrolled, do not require phytosanitary certification, and could thus enable *V. velutina* to enter the UK undetected.
1.7 How likely is the organism to survive during transport/storage?	Very likely – 4	Low – 0	Adult *V. velutina* could survive sometime if transported and/or stored with a suitable fruit/flower food source. No precise data is available for this species, but in theory *V. velutina* could last several days. On at least three occasions adult *V. orientalis* have been found live, on fruits imported into the UK, in one case surviving transport/storage from Israel (Plant Health Interception Records, Fera).
1.8 How likely is the organism to multiply/increase in prevalence during transport /storage?	Very unlikely – 0	Low – 0	Conditions during transport/storage would not be compatible with nest building and breeding for *V. velutina*. Numbers of hornets would tend to decrease, due to lack of other (protein) food sources, and sub-optimal temperature, humidity etc. during confinement.
1.9 What is the volume of movement along the pathway?	Very high – 4	Low – 0	Detailed statistics about volume of fruits/plants imported into the UK, and their countries of origin can be found on Eurostat, 2010. (i) Third countries: The UK imports a wide range of fruits and flowers from third countries, including those where *V. velutina* is known to be present. For example, from China alone, the UK imports at least 19 types of fruit/fruit product. In 2009, the UK imported over 5 million tonnes of fresh apples and pears from this source, both fruits which are known to be utilised by foraging Asian hornets (Villemant & Haxaire, 2007). (ii) EU imports: The volume of trade with

			EU is also high (and far less restricted), and includes fruit types utilised by adult *V. velutina* e.g. in 2009 the UK imported 46,000 tonnes of fresh table grapes from France.
1.10 How frequent is movement along the pathway?	Very frequent – 4	Low – 0	Frequency of import depends on the fruit/plant product in question. However, large volumes of all types of fruit are imported throughout the year (Eurostat, 2010).
1.11 How widely could the organism be distributed throughout the Risk Assessment area?	Very widely – 4	Low – 0	Imported fruits and flowers are distributed and sold throughout the Risk Assessment area. Oriental hornets travelling on imported fruits/plant products have been intercepted in Birmingham, Hull, Liverpool, Kent, Northamtonshire, Worcester and London (Plant Health Interception Records, Fera)
1.12 How likely is the organism to arrive during the months of the year most appropriate for establishment ?	Very likely – 4	Low – 0	(i) Imports/movements could potentially occur at any time of the year. Fruit hosts known to be used as food sources by *V. velutina* are imported into the UK throughout the year from countries known to have Asian hornets (Eurostat, 2010). (ii) Interceptions of Oriental hornets imported into the UK have occurred throughout the year (February, March, April, May, June, December) (Plant Health Interception Records, Fera). (iii) Inseminated queens arriving early in the season (spring) could establish new nests. (iv) Inseminated queens arriving in the autumn could overwinter in the UK. (V) Irrespective of the date of arrival, worker hornets would not be expected to establish in the Risk Assessement area – this life stage is not capable of reproducing, and is also dependent on a colony of co-workers for survival.
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?	Moderately likely – 2	Mediem - 1	Depends on the commodity. h the type of fruit imported: Dessert apples and pears may be sold from market stalls in the open air, aiding dispersal; strawberries imported for jam-making will be processed accordingly.
1.14 How likely is the organism to be able to transfer from the pathway to a suitable habitat?	Likely – 3	Low – 0	(i) The life stage being imported with fruit/flowers is likely to be adult hornets. Note: these only pose a threat of establishment in the Risk Assessment area if they are mated queens – only these insects are capable of establishing new

			colonies. (ii) Asian hornets imported with controlled fruits/plant products from third countries come in through ports and airports. Should such consignments be left in the open, then wasps could readily disperse from these points of entry. (iii) Similarly, imported fruits/flowers (EU and 3rd country) are distributed to many different kinds of outlets throughout the Risk Assessment area (supermarkets, processing plants, small scale green-grocers, florists etc.), at least some of which will be out of doors (e.g. market stalls). (iv) Queen hornets are highly mobile, and very adaptable – they are unlikely to have to travel far to locate suitable habitats – but habitat requirements will vary, depending on time of year at entry: (v) If a mated queen arrives in the autumn, she will need to find a place to hibernate until the following spring. The likelihood of finding suitable hibernation sites is high, given that any small, concealed well-insulated site may suffice. (vi) A mated queen arriving in spring or summer months can found a new colony – (see Pathway 1. response to Question 1.14) - all resources to meet *V. velutina*'s basic requirements are widespread throughout the UK, including areas associated with this Pathway. (vii) The distribution of the native European hornet *V. crabro* within the Risk Assessment area is largely confined to England south of Yorkshire and Wales (Edwards, 1997) – assuming requirements of *V. velutina* are similar, then likelihood of transfer to a suitable habitat from this pathway will be greatest within these areas.
1.2 Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	**Pathway 6. Movement on freight containers and transport vehicles themselves.**		
1.3 How likely is the organism to be associated with the pathway at origin?	Unlikely – 1	Medium - 1	(i) The potential with this Pathway is that inseminated Asian hornet queens could either travel as active adult hitchhikers, or as dormant hibernating queens. (ii) Asian hornet workers could also travel by this Pathway, but these do not pose a threat of establishment in the Risk Assessment as they are

			incapable of establishing new colonies. (iii) No records were found of *V. velutina* queens being directly associated with transport vehicles, or of Asian hornet queens using freight or transport vehicles as hibernation sites.
1.4 Is the concentration of the organism on the pathway at origin likely to be high?	Very unlikely – 0	Low - 0	(i) It is considered unlikely that large numbers of *V. velutina* would associate with this Pathway at origin, but no records were found to support this assumption. (ii) Records of hornet queens forming swarms are very rare (Mulhauser & Vernier, 1994), and the frequency of such swarming behaviour in Asian hornets is unknown. However, there are reports of other social Hymenoptera (honey bees) forming swarms on ships, and hitchhiking to countries outside their normal range (Tarpy, 2007). (iii) Bee swarms have also occasionally been picked up on ships arriving in the UK (National Bee Unit (NBU) *pers. comm.*).
1.5 How likely is the organism to survive existing cultivation or commercial practices?	Likely – 3	Low - 0	There are no known consistently-used management practices on this Pathway. Some containers may be fumigated during transport, depending on the consignment.
1.6 How likely is the organism to survive or remain undetected by existing measures?	Moderately likely – 2	Medium –1	Depends on the lifestage in question: (i) It is highly unlikely that a swarm of Asian hornets would go undetected – these are highly active, often aggressive stinging insects. (ii) By contrast, hibernating queens of *V. velutina* are much more discrete, and could potentially escape visual inspection.
1.7 How likely is the organism to survive during transport/storage?	Moderately likely – 2	Medium –1	Depends on the lifestage in question: (i) Under normal circumstances, the lifespan of an adult female *V. velutina* is 24-142 days, and an adult male 4-60 days (Dong & Wang, 1989), but this assumes access to food, water and shelter. (ii) It is very unlikely that active adult Asian hornets would survive for more than a day or two during transport and storage, especially without water. (iii) Specific data re. duration of Asian hornet hibernation under natural circumstances is limited, but it typically lasts about 4 months (Dong & Wang, 1989) – far longer than typical duration of transportation. (iv) Length of storage commodity depends on goods involved.

1.8 How likely is the organism to multiply/increase in prevalence during transport /storage?	Very unlikely – 0	Low – 0	(i) Numbers of active adult *V. velutina* would be more likely to decrease, due to hornets dying during transport/storage (lack of food and water). (ii) Hibernating queens of *V. velutina* are dormant – i.e. not in physiological state at which multiplication will occur.
1.9 What is the volume of movement along the pathway?	Very high – 4	Low - 0	Unknown. Depends on transport involved. However, traffic of freight/transport vehicles into the Risk Assessment area from areas affected with Asia hornets is high and constant throughoutthe year.
1.10 How frequent is movement along the pathway?	Very high - 4	Low – 0	Unknown. Depends on transport involved. . However, traffic of freight/transport vehicles into the Risk Assessment area from areas affected with Asia hornets is high and constant throughoutthe year.
1.11 How widely could the organism be distributed throughout the Risk Assessment area?	Very widely – 4	Low – 0	Unknown. Depends on transport involved. However, potentially anywhere in Risk Assessment area.
1.12 How likely is the organism to arrive during the months of the year most appropriate for establishment ?	Very likely – 4	Low – 0	(i) Could potentially arrive at any time of year, depending on origin. (ii) Establishment in Risk Assessment area via this Pathway can only occur if the hornet in question is an inseminated queen – only this life stage can found a new colony. (iii) Inseminated queens arriving early in the season (spring) could establish new nests. (iv) Inseminated queens arriving in the autumn could overwinter in the UK.
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?	Moderately likely – 2	Low - 0	By virtue of the Pathway, which involves mobile transport, this will aid distribution. Likelihood of arrival at suitable habitat depends on the transport involved.
1.14 How likely is the organism to be able to transfer from the pathway to a suitable habitat?	Likely – 3	Medium – 1	(i) Adult workers: The length of time which an Asian hornet worker can survive away from her colony is unknown – an individual arriving in the Risk Assessment area via this Pathway would only be expected to survive in the short term, depending on access to food and shelter, but she would not be capable of independent existence long term - this life stage is also dependent on a colony of co-workers for survival. (ii)

			Hornet queens are highly mobile and very adaptable – they are unlikely to have to travel far from the Pathway to locate suitable habitats. (see Pathway 1. response to Question 1.14) - all resources to meet *V. velutina*'s basic requirements are widespread throughout the UK, including areas associated with this Pathway. (iii) *V. velutina* queens could potentially fly off a ship or plane on landing, and find a suitable habitat – beekeeping is widespread throughout UK, and is practiced near ports and freight depots. (iv) The distribution of the native European hornet *V. crabro* within the Risk Assessment area is largely confined to England south of Yorkshire and Wales (Edwards, 1997) – assuming requirements of *V. velutina* are similar, then likelihood of transfer to a suitable habitat from this pathway will be greatest within these areas.
1.2 Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	**Pathway 7. Movement of honey bees: queens and packaged bees (workers) for the purposes of trade. From the EU only this also includes the movement of whole colonies.**		
1.3 How likely is the organism to be associated with the pathway at origin?	Unlikely – 1	Low – 0	(i) Although Asian hornets' preferred food source is honey bees, *V. velutina* are comparatively unlikely to be associated with this Pathway. Adult hornet workers do not live inside colonies of *A. mellifera*, but only enter to raid eggs and larvae. (ii) Apart from early in the season, when hornets are establishing founder nests, inseminated queens do not enter beehives – inseminated queens are the only life stage that can establish in the Risk Assessment area. (iii) Other life stages of *V. velutina* (eggs, larvae, pupae) are never associated with adult bees. (iv) Although there are no reports of *V. velutina* queens hibernating inside overwintering honey bee colonies, other social wasps frequently use honey bee hives as refuges, often hiding spaces between hive crown boards and roofs; in 2009 up to 90% of the NBU's 130 hives contained at least one inseminated *Vespula spp.* (*germanica* or *vulgaris*) queen during the winter period, and some apiaries contained as many as 40 individuals (pers. comm. Jack Wilford, NBU).
1.4 Is the concentration of the organism on the	Very unlikely	Low - 0	Precise population concentrations of *V. velutina* in those

pathway at origin likely to be high?	– 0		countries that export honey bees where Asian hornets are present (France, Spain, China, Hong Kong, India and Thailand) are unknown. However, as many as ten *V. velutina* nests have been reported in a radius of 600m (Villemant & Haxaire, 2007). There are no records of *V. velutina* being concealed and transported when a hive has been moved.
1.5 How likely is the organism to survive existing cultivation or commercial practices?	Very likely – 4	Low – 0	Experiences of French beekeepers demonstrate that existing beekeeping practices are unlikely to have any negative effects on *V. velutina* populations.
1.6 How likely is the organism to survive or remain undetected by existing measures?	Very unlikely – 0	Low – 0	Adult *V. velutina* are comparatively large, and highly active, and are very likely to be detected in any inspected consignments. The authoritative legal position for the importation of bees into the UK can be found in the appropriate national legislation which is available at: http://www.opsi.gov.uk/stat.htm and the European Commission legislation may be found at: http://eur-lex.europa.EU/RECH_menu.do?ihmlang=en It is also summarised in document: The Importation of Bees into England – A Guidance note for Importers (Fera, 2009). (i) Third country imports: Honey bees may be imported into the EU from third countries provided that the three notifiable pests of bees in the EU, (Small hive beetle, American Foul Brood, and *Tropilaelaps* mites), are confirmed as notifiable throughout the exporting country. Only Argentina, Australia and New Zealand currently meet these requirements. *V. velutina* is not believed present in these countries (EPPO, 2007). To import honey bees from other third countries, checks have to be made that they are able to comply with the requirements of the EC health certificate. Eligible third countries include the following which are known to have *V. velutina*: China, Hong Kong, India and Thailand (Bee Health Policy, 2009). Imports from these countries are restricted to queen bees and no more than 20 attendant workers. All honey bees imported directly into England from a third country must enter through one of two designated Border Inspection Posts

			(BIPs) – Heathrow and Gatwick airports – where they are inspected by Veterinary Officers. As well as being accompanied by an appropriate health certificate the import should be notified in advance via the TRACES (Trade Control and Expert System) (See Brown, 2006a for more information on TRACES) and the National Bee Unit (NBU) should also be notified of the import. All third country imports should be examined (Bee Health Policy, 2009; NBU, 2010). (ii) Imports from the EU: Consignments of honey bees from other EU member states must be accompanied by an original health certificate (Annex E part 2, Council Directive 92/65/EEC) – the electronic paperwork of which is held on the TRACE system. Importers must also give 24 hours written notice to the Animal Health Office responsible for the region where their consignment is destined to arrive. This letter, copied to the NBU gives details of the planned date and arrival time and details of the final destination. NBU inspectors have the power to check the paperwork and have a requirement to look at the paperwork of 50% of consignments. 10% of these must be subject to physical checks, however there is no border inspection point for the checks of EU imports. The checks may not be at the point of entry at all, but at the final destination. The physical checks may therefore involve checking an imported nucleus or full sized colony for pests and diseases and possibly checking the colonies into which imported queens have been introduced (Brown, M., 2006b; Bee Health Policy, 2009; NBU, 2010). (iii) Current legislation greatly limits the chances of *V. velutina* entering undetected, but does not rule it out - not all consignments are physically checked in the UK and checks may only be done at the final destination of the consignment and not the point of entry. There is additional uncertainty over the detection of honey bee pests due to the possibility of illicit trade entering the UK without any documentation and no notification of the authorities. Volume of this trade is unknown, but is likely to

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<tr><td></td><td></td><td></td><td>be larger from the EU than third countries due to the ease of transport. However, given size of adult V. velutina, the likelihood of it being noticed in any consignment, legal or otherwise, is considered to be extremely low.</td></tr>
<tr><td>1.7 How likely is the organism to survive during transport/storage?</td><td>Very likely – 4</td><td>Low – 0</td><td>If honey bees can survive transport or storage, in theory so could V. velutina. Solid sugar based food, known as candy or fondant, is usually provided to sustain the honey bees themselves during transport (NBU, pers. comm.), which would also be available to the hornet.</td></tr>
<tr><td>1.8 How likely is the organism to multiply/increase in prevalence during transport /storage?</td><td>Very unlikely – 0</td><td>Low – 0</td><td>The conditions required by Asian hornets for reproduction/oviposition are entirely dissimilar to those provided in imported honey bee consignments.</td></tr>
<tr><td>1.9 What is the volume of movement along the pathway?</td><td>Low – 1</td><td>Low –1</td><td>(i) Legal trade volumes from both third countries and the EU are documented (The level of illicit trade entering the UK is unknown and by its nature not monitored (NBU, pers. comm.)). (ii) Volume of trade from third countries: In 2010 no honey bee queens were imported into England and Wales from any third countries where V. velutina is present (NBU, 2010). (iii) Volume of trade from the EU: Table 1. Shows numbers of honey bees (queens or nucleus colonies) imported from the EU into England/Wales in 2010. Only 6 consignments originated in France, and just one from Spain i.e. from countries where V. velutina is known to be present.
<table>
<tr><th colspan="4">Table 1.</th></tr>
<tr><td>Country of origin</td><td>No. of consignments imported</td><td>Batched no. of queens</td><td>Batched no. of nucleus</td></tr>
<tr><td>Austria</td><td>1</td><td>15</td><td>0</td></tr>
<tr><td>Cyprus</td><td>15</td><td>305</td><td>352</td></tr>
<tr><td>Czech Republic</td><td>3</td><td>130</td><td>0</td></tr>
<tr><td>Denmark</td><td>9</td><td>74</td><td>0</td></tr>
<tr><td>France</td><td>6</td><td>239</td><td>0</td></tr>
<tr><td>Germany</td><td>13</td><td>183</td><td>0</td></tr>
<tr><td>Greece</td><td>56</td><td>4285</td><td>0</td></tr>
<tr><td>Hungary</td><td>1</td><td>50</td><td>0</td></tr>
</table>
</td></tr>
</table>

			<table><tr><td>Ireland</td><td>3</td><td>50</td><td>0</td></tr><tr><td>Italy</td><td>3</td><td>300</td><td>0</td></tr><tr><td>Slovenia</td><td>13</td><td>1660</td><td>0</td></tr><tr><td>Spain</td><td>1</td><td>0</td><td>100</td></tr><tr><td>Total</td><td>124</td><td>7291</td><td>452</td></tr></table>
1.10 How frequent is movement along the pathway?	Infrequent – 1	Low – 0	Annual imports of honey bees are typically between April and September, regardless of whether the imports are of EU or third country origin (NBU, pers. comm.).
1.11 How widely could the organism be distributed throughout the Risk Assessment area?	Very widely - 4	Low – 0	(i) Imported bees can be introduced anywhere, as beekeeping is practiced throughout the UK. (ii) However, it is unlikely that *V. velutina* would be spread widely through this Pathway as volume of trade with relevant countries where Asian hornets are present is extremely low (See above).
1.12 How likely is the organism to arrive during the months of the year most appropriate for establishment ?	Very widely - 4	Low – 0	Importation (April-September) takes place during the key beekeeping months of the year in the UK. In theory, these months will all allow establishment of *V. velutina* queens, either by founding new nests (if arrive early in the season), or by finding a suitable hibernation site and overwintering until next spring (if arrival is late in 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?	Very widely - 4	Low – 0	Imported honey bees need to be maintained alive and in good health, and will not be "processed"; they are provided with environmental conditions (food, no harmful pesticide treatments) equally conducive to *V. velutina* survival; imported bees are released into habitats suitable for hornet survival.
1.14 How likely is the organism to be able to transfer from the pathway to a suitable habitat?	Very likely - 4	Low – 0	Being transported with honey bees, *V. velutina* would enter the Risk Assessment area already associated with suitable prey items, and would be immediately transferred into an area where beekeeping is practised (i.e. a suitable habitat).
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	Similar – 2	Low – 0	(i) Although *V. velutina*'s native range is within NE India, S. China and Taiwan & Indonesia, even in such tropical regions this species nests in cooler highland regions, which are

distribution?			climatically similar to Southern Europe (Starr, 1992; Martin, 1995). (ii) *V. velutina* has established in many regions of France, incuding Northern Brittany (since 2008), which shares the ecoclimatic conditions found in the Risk Assessment area. (Ille-et-Vilaine in 2008; Côte-d'Armor in 2010) (iii) Maximum Entropy (MAXENT) models based on records of the distribution of *V. velutina* in Asia and France predict that Occidental Europe (which includes UK) is climatically very suitable for colonisation by the Asian hornet (Rome *et al*., 2009). (iv) This climate-matching study is based on the subspecies *V. velutina* <u>*nigrothorax*</u>, the subspecies introduced into France and the one posing a threat to UK (i.e. it is highly likely to have yielded realistic colonisation projections in terms of climate) – it is the view of recent authors that GB is climatically highly suitable for the establishment of *V.v. nigrthorax* (Villemant *et al.,* 2011a; b). (v) *Vespa* species are very effective at regulating the temperature within their nests, protecting adults and brood from ambient temperature extremes (Martin, 1990); they can maintain a constant nest temperature around 30^{o}C, even if temperatures outside the hive may be 20^{o}C lower. (v) Under laboratory conditions, *V. velutina* has been shown to complete its lifecycle under a wide range of conditions (14^{o}-25^{o}C, r.h. 43-89%) (Dong & Wang, 1989).
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 - 3	Low – 0	(i) Since its entry and establishment in EU (France and Spain), *V. velutina* has rapidly adapted to this new environment, colonising urban, sub-urban, agricultural and wooded areas (Haxaire *et al*., 2006; Chauzat & Martin, 2009). (ii) Recent survey of French nests shows that most (49%) are found in urban or semi-urban environments. Others (43%) are sited in agricultural landscapes, forest settings (7%) or, rarely in damp or wet environments such as marshlands (1%) (Villemant *et al*., 2011a). (iii) All of these man-made and/or unmanaged environments are equally available 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	(i) The complete dietary range of *V. velutina* is unknown, but under investigation (Villemant *et al*., 2011a). (ii) Although the preferred food is *Apis mellifera* the European honey bee (Shah & Shah, 1991; Perrard *et al*., 2009), it is highly polyphagous - it will not have to rely on honey bees for establishment and spread (iii) In England and Wales there are in excess of 20,000 registered beekeepers, who together manage around 110,000 colonies (NBU, 2010), and it is estimated that there may be many more who are not registered on BeeBase (NBU pers. comm.). Thousands more managed colonies of *A. mellifera* are kept in Scotland (est. 20,000 NBU pers. comm.) (iv) In addition, an unknown number of feral *A. mellifera* colonies are present in the Risk Assessment area (Thompson *et al*., 2010). (v) *V. velutina* does not only eat honey bees; they predate other social Hymenoptera and in France, have also been observed taking flies, butterflies, caterpillars, and also vertebrate flesh (Villemant *et al*., 2006a; 2006b; Villemant & Haxaire, 2007; Perrard *et al*., 2009). (vi) In general, hornet species feed almost exclusively upon animal prey, including bees, crickets, butterflies, flies and other insects, as well as spiders (Mollet *et al*., 2006; 2007). (vii) Adult *V. velutina* are known to feed on ripe fruit (apples, plums, grapes etc.) at the end of the season (Villemant & Haxaire, 2007). (viii) All of these additional food sources are present in numerous habitats throughout the Risk assessment area: woodlands, farmland, orchards, suburban landscapes, gardens, allotments etc.
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	(i) Beekeeping is widespread throughout the Risk Assessment area. 80% of managed *A. mellifera* are found in England, the rest being in Scotland & Wales (and N. Ireland) (NBU, 2010). (ii) Other potential food species (insects and fruit, see above) are variously abundant and 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	N/A		

the organism to become associated with such species in the risk assessment area?			
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	(i) Europe has two native hornet species, but only one of these, the European hornet *V. crabro* L., is found in the Risk Assessment area (Matsuura & Yamane, 1990; Carpenter & Kojima, 1997; Villemant & Haxaire, 2007). (ii) No information currently available about impact of *V. velutina* on *V. crabro* numbers in France or *vice versa*. (iii) Studies of diverse hornet communities in Eastern Asia demonstrate that species are able to co-exist where nesting habits, foraging habits and life history patterns are species-specific and do not overlap - *V. crabro* is distributed sympatrically with four other *Vespa* species within is Asian range (see references in Ross & Matthews, 1991). Although *V. crabro* and *V. velutina* are broadly similar in their basic biology, differences in prey-preferences, nesting sites and life-histories (timing of queen production) may thus allow co-existence. (iv) Although distribution is quite broad, *V. crabro* favours forests, woods and open countryside and is rarely seen outside of these habitats. This means that in other (urban or suburban) areas utilised by *V. velutina*, *V. crabro* is unlikely to be present or compete for resources. (v) Queens of *V. crabro* subspecies are known to visit nests of conspecifics, causing resident queens and workers to fight for nest possession (Nixon, 1983; 1986), and there are reports of *V. velutina* nests being taken over by other *Vespa* species within their Asian distribution (see references in Ross & Matthews, 1991). Such observations indicate at least the potential for usurpation by native species, but there are no recent records of such behaviours between French populations of *V. crabro* and *V. velutina*. (vi) In France and Spain, where *V. crabro* is also present, this has not prevented the establishment of *V. velutina* (Mollet *et al*., 2006; 2007; Chauzat & Martin, 2009). (vii) More studies re. the comparative biologies of *V. crabro* and *V. velutina* are required. Details re. biology of V. *velutina* currently under

			investigation by Muséum National d'Histoire Naturelle & Institut de Recherche sur la Biologie de l'Insecte, France.
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	(i) Social wasps are affected by a variety of pests and pathogens, including bacteria, nematodes, fungi, protozoa and viruses (Rose *et al*., 1999), but the full range of *V. velutina*'s natural enemies is unknown. (ii) Natural enemies may include the parasitic Stylopidae and Tachinidae (Dong & Wang, 1989). Both these families are represented in the Risk Asessment area, but their specific associations with *V. velutina* are undocumented. (iii) Levels of parasitism of other hornet species by Stylopidae can be high (up to 60%) (Makino &Yamashita, 1998; Tatsuta & Makino, 2003). (iv) In their immature stages, some hornet species are parasitized by mites, or icheumonid or trigonalid wasps (Muzaffar & Ahmad, 1986; Ono, 1987; Havron & Margalith, 1995), and pyralid moth larvae may also damage hornet brood (Martin, 1992), but this has not been recorded in *V. velutina*. (v) Birds known to predate *V. velutina*, present in the Risk Assessment area include shrike, woodpeckers, jays and tits (Mollet *et al*., 2006; 2007; Villemant & Haxaire, 2007). Shrike actively predate adult *V. velutina* (Villemant & Haxaire, 2007), but these birds are very uncommon in the UK (Battern *et al*., 1990). Woodpeckers feed on hornet larvae and adults left in the colony at the end of the autumn (Villemant & Haxaire, 2007). As scavengers of dead/dying *V. velutina* colonies, they are not expected to have any significant impact on breeding hornet numbers. The likely impact of tits and jays is unknown, but is likely to be low, and their presence has not prevented establishment in France or Spain. (vi) *V. velutina* occasionally nests underground (Martin, 1995); also, groups of queens will hibernate under stones: The susceptibility of *V. velutina* to subterranean/soil-dwelling natural enemies (e.g. nematodes, entomopathogenic fungi) present in the Risk Assessment area is unknown. However, other hornet species are known to be susceptible to endoparasitism by the nematode *Sphaerularia*

			vespae, resulting in their sterilisation (Kanzaki *et al*., 2007; Sayama *et al*., 2007). *Sphaerularia sp.* affects UK bumblebees.
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)	N/A		No known differences occur
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	(i) Control measures for hornets have been summarised by Fell (1997). Methods documented for *V. velutina* include baited traps (Kshirsagar, 1971; Shah & Shah, 1991), killing hornet queens in early spring, destroying hornet nests, and swatting hornets at hive entrances (Shah & Shah, 1991; Builles, 2008). (ii) None of these are reported as effectively preventing establishment in France (Chauzat & Martin, 2009). (iii) Reducing hive entrances to 6mm high might deter hornet entry, but traditional metal entrance strips are ineffective (Mollet *et al*., 2006; 2007).
1.24 How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	Never – 0	Low – 0	No records of *V. velutina* in protected conditions have been found.
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	(i) Mated queens emerge from over-wintering hibernation in spring, and found a small embryo in which to rear their first batch of workers (Martin, 1995) – speed of this process likely to aid establishment. (ii) *V. velutina* will build embryo nests in a variety of places, as long as these are enclosed and protected (e.g., tree hollow, wall cavity) (Chauzat & Martin, 2009) – flexibility in terms of nesting requirements likely to aid establishment. (iii) *V. velutina* (subspecies *auraria*) can cope with rapid nest growth moving the developing colony to a new, larger site as the number of workers grows (Dahzi & Yunzhen, 1989) – increases distribution in Risk Assessment area. (iv) Mature nests are typically near the tops of trees but will also use a variety of man-made substitutes (buildings) (Chauzat & Martin, 2009) – adaptability likely to aid

			establishment. (v) Nests expand very quickly, as increasing numbers of workers help to rear more and more workers, with the queen now restricted to egg-laying within the nest (Chauzat & Martin, 2009). Asian hornet colonies can be very large (much larger than those of native *V. crabro* (Villemant & Haxaire, 2007)), reaching over 75cm in length, and containing 12,000 brood cells (Martin, 1995) – large nests with many workers likely to aid establishment (nest size is maximum in the autumn, when it may contain >1,000 adult workers). (vi) One colony of hornets may produce hundreds (or even thousands) of new queens – each mated queen has potential to found a new colony, so shear numbers likely to greatly aid establishment. (vii) Workers and males die at onset of winter, but mated queens hibernate, in a very wide variety of concealed crevices - flexibility in terms of hibernation requirements likely to aid establishment: In other social wasp species this behaviour has allowed survival in cargo, and subsequent transportation to distant parts of the world; the European wasp (German yellow jacket) *Vespula germanica* was accidentally introduced into Tasmania via this Pathway in the 1950s (Spradbery & Maywald, 1992); *V. germanica* entered New Zealand (NZ) when hibernating queens were shipped in with US aeroplane parts from Britain in the 1940s (Fordham, 1961). Furthermore, in NZ their spread over large distances has been attributed to rail and road transport carrying hibernating queens (Fordham, 1961). (viii) Worker hornets cannot digest animal prey directly, but give this to their larvae, which then produce carbohydrate and amino acid rich secretions on which the adults feed. As the colony declines at the end of the season, workers must seek out other sources of sweet food elsewhere (Chauzat & Martin, 2009). For these reasons *V. velutina* is especially attracted to ripe fruit at the end of the summer (Mollet *et al*., 2006; 2007), increasing the potential for inseminated queens to associate with produce intended for export.

1.26 How likely is it that the organism's capacity to spread will aid establishment?	Likely – 3	Low - 0	(i) *V. velutina* adults are strong fliers, but no records of distances covered by mated queens in search of new nests could be found. (ii) Spread in France (and into Spain) has been rapid, with the Asian hornet now present in at least 39 départements since first introduction in 2003-2004 (Haxaire *et al.*, 2006; Chauzat & Martin, 2009; Villemant *et al.*, 2010; 2011a). (iii) However, the contribution made to this spread by other factors (e.g. bee management practices, inadvertent transport with fruit, soil etc.), is unknown.
1.27 How adaptable is the organism?	Highly adaptable – 3	Low – 0	Chauzat and Martin (2009) state that "A key characteristic of hornets such as *V. velutina* is their resilience to environmental change and their capacity to overcome difficulties". Their high level of adaptability is evident in the speed with which they have become established outside their native range, since first arrival in France in 2004 (now present in at least 39 départements and have entered Spain (2010)) (Haxaire *et al.*, 2006; Chauzat & Martin, 2009). They possess a variety of traits that contribute to this adaptability: (i) Asian hornets' ability to thermoregulate (see response to Question 1.15) allows them to forage even when ambient temperatures are relatively low; (ii) Unlike some other types of hornet, *V. velutina* adults remain active even under rainy and cloudy weather conditions (Perrard *et al.*, 2009). Hornet larvae are also able to tolerate a range of temperatures. (ii) Although they prefer honey bees as prey, *V. velutina* use a variety of alternative food sources (see response to Question 1.17); (iii) They will use a variety of nesting sites (garages, sheds, under decking, trees, wall cavities etc.). (iv) Note: Asian hornets favour open areas, near water (Builles, 2008), and will tend to follow rivers and watercourses (Anon, 2010). They appear to require access to a water source, even if that is only a small pool or puddle (Anon, 2010).
1.28 How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	Unlikely – 1	Low – 0	(i) Prior to introduction to the Risk Assessment area, it is impossible to know the genetic diversity of the founder population. (ii) Assuming a single introduction, genetic

			diversity will be low; in the event of multiple introductions into the Risk Assessment area, diversity would be higher. (iii) In captive colonies of *V. velutina*, it has been observed that aggression towards newly-introduced hornets of the same species is rare and very mild (Perrard *et al*., 2009). This unusually passive, altruistic acceptance of intruders of the same species has been attributed to the genetic proximity of *V. velutina* colonies in France (Perrard *et al*., 2009). This phenomenon has been observed in other invasive social Hymenoptera (Holway *et al*., 1998). This hypothesis has not been confirmed, but offers an explanation for the rapid establishment and spread of Asian hornets in France. Low genetic diversity associated with low intraspecific aggression could assist spread.
1.29 How often has the organism entered and established in new areas outside its original range as a result of man's activities?	Infrequently – 1	Medium - 1	(i) It is believed that *V. velutina* was introduced to France in 2004 or earlier, in boxes of china pots imported from Yunnan by a French bonsai producer (Villemant *et al*., 2006a). The Bonsai producer had imported from this country of origin for several years, and noted more than one embryo nest in his locality. (ii) Although authors have attributed *V. velutina*'s rapid spread in France to multiple introductions (Builles, 2008) the single introduction hypothesis is now favoured (e.g. Jourdain, 2010) – recent molecular characterisation of the line of invasive Asian hornets in France reveal a high degree of homogeneity consistent with a single introduction (Villemant *et al*., 2011a; b) – Microsatellite marker studies likewise indicate existing French populations arose from a single female mated by several males (Arca *et al*., 2009)*. (iii) Molecular comparisons between *V. velutina nigrithorax* collected from Shanghai Province and French specimens are in progress, to confirm the original Chinese site of origin (Arca *et al. in prep*. 2011). (iv) It has been reported that in spring 2007, a "nest" of *V. velutina* was destroyed in Bruges after being found in a container of electronics components imported from Asia (Builles, 2008), but this has not been

			confirmed. (v) *V. velutina* was introduced into Korea around 2006, but it is not known whether this was as a result of man's activities, or by natural spread (Kim *et al.,* 2006). *(By contrast, analysis of microsatellite loci of the European hornet *V. crabro* show that females of this species tend to be singly mated (64%). For most of those *V. crabro* queens that are multiply mated, paternity is significantly biased with the majority male fathering on average 80% of the female offspring (Foster *et al*., 1999)).
1.30 How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	Very likely – 4	Medium – 1	Very likely to survive eradication attempts (see response to Question 1.23). Since it's recent introduction to France, *V. velutina* is now well-established, and eradication is no longer considered to be achievable there (Chauzat & Martin, 2009; Villemant *et al*., 2011a).
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)?	Moderately likely – 2	Medium – 1	Permanent establishment likely. See response to Question 1.30.
Spread	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
2.1 How rapidly is the organism liable to spread in the Risk Assessment area by natural means?	Very rapidly – 3	Low – 0	Spread in France has been rapid, with the Asian hornet now present in at least 39 départements since first introduction in 2003-2004 (Haxaire *et al.*, 2006; Chauzat & Martin, 2009; Villemant *et al*., 2011a). In 2010, *V. velutina* was also confirmed present in Spain (Castro & Pagola-Carte, 2010). However, the contribution made to natural spread by other factors (e.g. bee management practices, inadvertent transport with fruit, soil etc.) is unknown.
2.2 How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	Moderately – 1	Low - 0	See response to Question 2.1, above.
2.3 How difficult would it be to contain the organism within the Risk Assessment area?	Very difficult – 4	Low – 0	Efforts to contain *V. velutina* upon discovery in France have been unsuccessful (Mollet *et al*., 2006; 2007; Chauzat &

			Martin, 2009), and have not prevented its entry into Spain (Castro & Pagola-Carte, 2010).
2.4 Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.	Wide area	Low - 0	The Asian hornet could establish and spread throughout the Risk Assessment area – suitable prey (the honey bee *A* mellifera) and habitats are widespread across UK. Potential for establishment may be relatively greater in the following areas: (i) Areas where winters are milder (southern English counties) (the number of mated Asian hornet queens that survive hibernation is moderated by overwinter mortality (Chauzat & Martin, 2009)). (ii) Open areas near water (Builles, 2008), hornets tending to follow rivers and watercourses (Anon, 2010); (iii) Near ports and airports, where controlled and uncontrolled consignments of commodities that may harbour overwintering queens are most likely to enter the Risk Assessment area; (iv) In the event that *V. velutina* crosses the English Channel, either on shipping or by natural spread, coastal counties of southern England will be most at risk.
Impacts	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
2.5 How important is economic loss caused by the organism within its existing geographic range?	Moderate – 2	High – 2	Damage to managed honey bees. Although described as being "a serious pest of honey bees" (Shah & Shah, 1991), assessments of the economic impact of *V. velutina* in its existing geographical range are lacking. The predatory behaviour of *Vespa spp*. has been summarised by Fell (1997, and references cited therein). The primary effect of predation by Asian hornets is death of adult worker honey bees. Damage caused to honey bees and colonies is widely recognised in Asia (Williams, 1988; Shah & Shah, 1991; Abrol, 1994), but no data quantifying impact is available. *V. velutina* is capable of destroying up to 30% of an *A. ceranae* colony (Mollet *et al.*, 2006; 2007); just a handful of hornets can destroy an entire *A. ceranae* nest in a couple of hours (Mollet *et al*. 2006; 2007; Villemant & Haxaire, 2007; Anon, 2010). However, this "natural" prey has defense strategies that effectively reduce potential damage, including forming a

			compact mass of bees around the hornet, raising the temperature to a lethal 45^{o}C (Ken *et al*., 2005; Villemant & Haxaire, 2007). The European *A. mellifera* is less effective at this "heat-balling", and thus more vulnerable to colony damage (Anon, 2010). *V. velutina* (subspecies *pruthii*) cause heavy losses in Pakistan, not just by predating adult honey bees, but also by taking brood and honey reserves (Muzaffar & Ahmad, 1986). Repeated and sometimes severe attacks from *V. velutina* on French honey bee colonies were reported in 2006 and 2007, in particular in the summer and autumn, by beekeepers from the south-west regions of France (Perrard *et al*., 2009). Asian hornets also have indirect effects on honey bee health: Chronic hornet activity around a colony causes honey bees to mount a constant defence of the hive entrance, thus greatly limiting their time spent foraging (Builles, 2008). Pollen reserves become depleted, leading to mortality in developing bee larvae, weakening of the colony, and potential colony loss (Builles, 2008). Even low levels of hornet numbers (< 5 hornets/hive) can result in significant disruption (Anon, 2010). In France, *A. mellifera* colonies predated by *V. velutina* are typically left very weak, low in foragers or queenless, and vulnerable to disease, infestation and robbing (Mollet *et al*. 2006 2007; Anon, 2010). Damage to ripe fruit. Social wasps cause serious damage to apples, pears, plums, autumn strawberries and certain varieties of grapes (MAFF, 1983). Considerable wastage of goods is caused by wasps in sugar warehouses, jam factories and other places containing sweet, aromatic substances which attract them (MAFF, 1983). No quantitative records were found on this type of damage specifically caused by *V. velutina*, in its native range, but hornet species are known to damage ripe fruit when used as secondary food source (Chang, 1968).
2.6 Considering the ecological conditions in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g.	Moderate – 2	Medium - 1	(i) Honey bees are the major managed pollinator in the UK, and are known to susceptible to serious predation by *V. velutina*. Certain crops such as apples are heavily reliant on

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?			this type of commercial pollination, and without honey bees or a replacement pollinator, yields would be reduced. (ii) Honey production is dependant on a healthy honey bee population, which would clearly be effected in the event that bee numbers decline. (iii) Asian hornets pose additional risks to unmanaged pollinators, such as bumble bees, likely to have a further negative effect on crop production. (iv) Hornets also pose a threat to ripe fruit, which they may damage. (v) By way of comparison, the impact of the native European hornet *V. crabro* on *A. mellifera* is minimal – described as a "semi specialist" (Ross & Matthews, 1991), V. crabro predates honey bees, hoverflies (*Eristalis*), other social wasps (*Vespula rufa*) (Bunn, 1988a; Edwards, 1997), spiders, butterflies and moths (Edwards, 1997; Wiklund, 2005) and other large prey items such as (occasionally) dragonflies (Mauersberger & Mauersberger, 2001). It is reported to be a relatively mild predator of honey bees (Baracchi *et al*., 2010), but there is a single report in the UK of an entire *A. mellifera* colony being destroyed by *V. crabro* (Whitehead, 2007).
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	(i) If the UK were to suffer a total loss of pollinators (not just honey bees) the cost is estimated to be £440million per year, about 13% of the UK's income from farming (POST, 2010). Insect dependant crops can be pollinated by hand, but initial labour costs are prohibitive being estimated at £1,500 million. (ii) Honey production in the UK is typically worth between £10 and £35 million each year, and is entirely dependant on plentiful honey bee stocks. (iii) Although the loss of pollinators, including bees, would have a significant cost to crop production in the UK, the threat to food security posed by V. *velutina* may only be moderate, because key food crops such as cereals are wind-pollinated - a reduction in pollinating honey bees would notably reduce the diversity of food available, but not necessarily the quantity.
2.8 How great a reduction in consumer demand is the organism likely to cause in the Risk	Minimal – 0	Low – 0	Demand for honey and honey bee pollinated foodstuffs unlikely to be affected. Demand for fruit, if damaged by

Assessment area?			feeding hornets, is likely to be reduced. The presence of *V. velutina* in France, however, has not affected consumer demand.
2.9 How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	Unlikely - 1	Medium – 1	(i) The occurrence of *V. velutina* in France has not led to any restrictions on movements of bees or bee products from affected areas. However, should this situation be revised, in the UK export of bees is a relatively minor market. (ii) No limitations have been put on movements of fruit, soil, wood or wood products in other countries due to the presence of *V. velutina* – effects on such markets expected to be minimal unless this situation is revised.
2.10 How important would other economic costs resulting from introduction be? (specify)	Moderate – 2	High – 2	Costs are likely to be incurred from: research, advice, publicity to raise awareness, increased surveillance, increases in existing inspectorate, eradication/containment costs and training. Figures for these types of costs are very difficult to find, even for pests that have already established in the UK. A recent Australian paper considered the likely impact of the parasitic mite of honey bees, *Varroa destructor*, following its hypothetical introduction into Australia (Cook *et al*., 2007), and concluded that preventing entry avoided costs of over 38million US$, including loss of pollination, reduced crop yields, additionl production and eradication costs.
2.11 How important is environmental harm caused by the organism within its existing geographic range?	Moderate - 2	Medium – 1	(i) The environmental impact of the Asian hornet within its existing geographic range has yet to be fully documented. (ii) Ongoing research in France is investigating the range of insects predated by *V. velutina*, and has ascertained that it uses not just honey bees (the key managed pollinator of commercial crops and natural landscapes throughout the EU) but also social wasps, other Hymenoptera, several types of Diptera, and various unclassified insects (Villemant *et al*., 2011a), several of which are likely to provide unmanaged pollination services in a variety of man-made and "wild" scenarios – pollinator services will be adversely affected if predation by Asian hornets significantly reduces their numbers. (iii) Impact mechanisms are often complex and are

			not yet fully understood and quantified, even many years after the introduction of the wasps in new areas. Thus, it is likely to be some time before environmental impacts of the Asian hornet are fully understood. (iv) Asian hornets use a range of insect prey besides *A. mellifera*, including various unmanaged pollinators (e.g. wild bumble bees, flies). (v) The environmental harm caused by effects on pollination services in natural landscapes are undocumented in *V. velutina*'s existing geographical range.
2.12 How important is environmental harm likely to be in the Risk Assessment area?	Moderate – 2	Medium - 1	(i) Beekeeping is practiced throughout the Risk Assessment area and other, unmanaged pollinators are also likely to be predated by *V. velutina*, are present throughout the Risk Assessment area – pollination services may potentially be impacted (see 2.11 above). (ii) Environmental impacts of *V. velutina* are likely to vary, depending on nest location. Recent survey of French nests shows that most (49%) are found in urban or semi-urban environments. Others (43%) are sited in agricultural landscapes, forest settings (7%) or, rarely in damp or wet environments such as marshlands (1%) (Villemant *et al*., 2011a). Irrespective of nest site, the range of prey types is wide, and includes honey bees, social wasps, other Hymenoptera, several types of Diptera, and various unclassified insects. However, Asian hornets in urbanised locations take proportionally far more honey bees in their diets than those living in agricultural or forest environments. By contrast, hornets in less urban environments consume more flies (including hoverflies which are also important (unmanaged) pollinators) (Villemant *et al*., 2011a). (iii) Several other alien Vespidae have had serious environmental impacts on biodiversity through predation on, or competition with native preys and on the functioning of natural ecosystems, e.g. through the consumption of large quantities of honeydew. Examples include *Vespula germanica* and *V. vulgaris* in New Zealand, Australia or South America, *Polistes versicolor* in the Galapagos and *Polistes dominula* in

			North America (Kenis *et al*., 2009). (iv) Impact mechanisms are often complex and are not yet fully understood and quantified, even many years after the introduction of the wasps in new areas. Thus, it is likely to be some time before environmental impacts of the Asian hornet are fully understood.
2.13 How important is social and other harm caused by the organism within its existing geographic range?	Moderate – 2	Low – 0	(i) Likely proximity to human activity. Recent survey of Asian hornets' in France nests shows that almost (49%) are found in urban or semi-urban environments i.e. in relatively close proximity to human activity (Villemant *et al*., 2011a; b). (This contrasts to the native European hornet: although *V. crabro* will use manmade nesting sites (e.g. bird-nest boxes) Langowska *et al*., 2010), they favour natural sites such as hollow trees (Edwards, 1997)). A minority of *V. velutina* nests (3%) are located less than 2m off the ground, in bushes, hedges or (very rarely) in the soil, and *V. velutina* will also use man-made buildings as nesting sites. However, the majority (75%) are located at least 10m up in the canopies of large trees (Villemant *et al*., 2011b). (ii) Medical consequences. As a group, hornets possess highly poisonous venoms that they use to overcome their prey. These venoms are rich in toxins, enzymes and biologically active peptides (Joshua & Ishay, 1973; 1975; ZuoHong *et al*., 2006). However, while some hornet species have been known to inflict fatal stings on humans, this is unusual; deaths occurs only rarely, when victims receive multiple stings (Lubrano *et al*., 1985; Korman *et al*., 1990; Vetter *et al*., 1999; Kularatne *et al*., 2003), or as a result of anaphylactic shock (Miksic, 1972; Lee *et al*., 2005). Generally, although very painful, the effects of hornet stings are local and short-lived (Leclercq & Lecomte, 1975). Although *V. velutina* envenomation can cause severe adverse reactions (SheauChiou & YuYun, 1999; Haro *et al*., 2009), this has only been recorded after victims suffered multiple stings. In its native range, *V. velutina* is very aggressive (Matsuura, 1973; van der Vecht, 1957; Ho *et*

			al., 1999). (iii) Public nuisance. No quantitative data was obtained re. this type of harm caused by Asian hornets within their existing geographic range. However, social wasps have been described as one of the most "generally disliked" groups of insects (MAFF, 1983). Hornet abundance in urban areas (and intensity of nuisance interactions with people) varies with season (Matsuura, 2004). In the autumn, social wasps (including hornets) search for sweet, carbohydrate-based foods and may be attracted to human habitation/sites where such foodstuffs are available (e.g. picnic sites). Their presence can disrupt human enjoyment of outdoor parks and gardens (Beggs *et al*., 2001). (iv) Reduced Pollination (non-commercial). Besides being key crop-pollinators honey bees are also important pollinators in natural and semi natural environments. No quantitative data was obtained re. this type of environmental harm caused by Asian hornets within their existing geographic range.
2.14 How important is the social harm likely to be in the Risk Assessment area?	High -3	Low - 0	(i) Likely proximity to human activity. See above. (ii) Medical consequences. Observations of the aggressive behaviour of *V. velutina* in France (climatically more similar to the Risk Assessment area than typical native range) are inconsistent: Until recently, no aggravated response to human activity or loud noises was reported (Mollet *et al*., 2006; 2007; Perrard *et al*., 2009), and even when nesting in buildings (e.g. terraces or barns) *V. velutina* tended to "remain discrete", ignoring humans (Perrard *et al*., 2009). In France, in February 2009 just one envenomation had been clearly linked to *V. velutina*, and the French Poison Control Centre found no correlation between the expanding population of Asian hornets in France, and an increased number of Hymenoptera stings (Haro *et al*., 2009). However, in the autumn of the same year at least 7 people went to the hospital after being attacked by a single swarm of *V. velutina*. As a result, French authorities are warning people not to approach the nests, and to contact the police for help (Bond, 2009). (iii) Public

			nuisance. Because of its large size, *V. velutina* is intimidating to the public, and partly by virtue of its appearance, its arrival in France (and potentially the UK) has already attracted high profile press coverage (Allen, 2007; Anon, 2007; 2009; Bond, 2009; Samuel, 2009; Gray, 2010; Hari, 2010; McCarthy, 2010). Their mere presence in the Risk assessment area could disrupt human enjoyment of outdoor parks and gardens (Beggs *et al*., 2001). (iv) Reduced Pollination (non-commercial). The introduction of Asian hornets could impact on gardens, parks and allotments (though loss of honey bee and other insect pollinators), all of which have social and/or public amenity value within the Risk Assessment area. (v) Social harm caused by native European hornet. By way of comparison the social harm caused by the hornet species native to the UK, *V. crabro* is, overall, very low. *Vespa crabro* is a large wasp (queens 3cm long). Due its size and the fact that it is comparatively rarely encountered, in a typical year the National Bee Unit (NBU) receives several dozen samples submitted by concerned members of the public seeking identification (*pers. comm*. Selwyn Wilkins – Diagnostics Manager NBU). However, *V. crabro* is not generally aggressive, and attacks are uncommon. Stings from European hornet are painful, but effects are usually localised and short-lived. That said, severe and fatal allergic reactions (anaphylactic shock) have been recorded (Miksic, 1972; Hoffman *et al*., 1987; Antonicelli *et al*., 2002), with at least one instance of massive fatal envenomation as a result of multiple (>200) stings (Lubrano *et al*., 1985).
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?	Unknown		Unknown.
2.16 How probable is it that natural enemies, already present in the Risk Assessment area, will have no effect on populations of the	Very likely - 4	Medium – 1	Unknown. See response to Question 1.21

organism if introduced?			
2.17 How easily can the organism be controlled?	Very difficult – 4	Low – 0	Very difficult. See response to Question 1.30. Note that when *V. velutina* nests in tall trees or buildings, there are additional hazards associated with nest removal (Le Petit Journal, 2010).
2.18 How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	Unlikely – 1	Low – 0	A variety of chemical control measures are available for use against social wasps in the UK, including pyrethrins and methyl bromide. Some are available to the general public, and others are only registered for professional use. Commonly-used products such as Ficam D (active ingredient bendiocarb) are also highly toxic to bees (Rhodes & Scott, 2006), so have potential to damage beneficials. There have been recorded instances of mis-use and prosecutions as a result (Defra, 2008). However, such chemicals are routinely used to control social wasp species in the Risk Assessment area without significant disruption to existing biological or integrated systems for control of other organisms.
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	Medium - 1	Unknown. *V. velutina* enters colonies to feed on immature bees and honey. It also scavenges recently dead, and thus potentially diseased, bees (Shah & Shah, 1991). It therefore has the potential to pick up bee pathogens (bacteria, viruses etc.) and then spread them to any other colonies it visits. This is particularly likely with pathogens that have a resistant spore or cyst phase (Morse & Flottum, 1997, and refs. therein). However, there is very little available information about associations between any hornet species and other pests and diseases of honey bees. The UK's native hornet *V. crabro* can consume spores of the microsporidian parasite *Nosema apis* without themselves becoming infected, and then excrete viable spores which could potentially infect honey bees if expelled inside a colony during a raid (Shabanov & Kovachev, 1972).
2.20 Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur	Widespread	Medium – 1	Economic and environmental impacts likely to be similar in all areas where beekeeping is practiced (i.e. throughout Risk Assessment area). Social impacts are likely to be greatest in

			urban/sub-urban areas where opportunities for human contact (envenomation) greatest.
Summarise Entry	**Very likely – 4**	**Low – 0**	Overall, the assessors conclude that the Asian hornet *V. velutina* is very likely to enter the Risk Assessment area. There are multiple Pathways through which entry is possible, a high threat being posed by the movement of inseminated queen wasps, each one capable of producing an entire new colony. <u>Pathway 1. Natural spread by flight</u> is considered to be of high importance. In recent years at least one social wasp (e.g. the Median wasp) has entered the UK from mainland EU and become established, possibly after crossing the Channel in a single flight. It is possible, at least in theory, for *V. velutina* to do the same. Research into the flight capacity of *V. velutina* queens is ongoing – this is key information in terms of the risk of entry posed to the UK. Asia hornets are now present in at least one coastal region of Northern France. <u>Pathways 2. Entry of hibernating queens with wood/wood products</u> is considered to be of high importance. Asian hornets are known to hibernate under tree bark. The UK currently imports a variety of wood, wood products and also large ornamental trees (e.g. olives) from within *V. velutina'*s known range. Even on those Pathways where detection measures exist (e.g. movement of wood, wood products), uncontrolled imports may not be treated or inspected. *V. velutina* is not currently classed as a quarantine plant or tree pest or disease, so on those occasions when controlled imports are inspected, it's presence may not necessarily be noted. <u>Pathway 3. Entry of hibernating queens on man-made commodities</u> is considered to be of intermediate importance. Likelihood of entry is heightened by the fact that inseminated queens hibernate in discrete crevices, making them difficult to

			detect. Moreover, hibernation sites may include an enormous variety of man-made harborages – potentially any small, well-insulated refuge in which they can be concealed over the winter months. This means that detection and control of hornets on all possible commodities and at all possible points of entry is unlikely to be feasibly possible. Considered on an individual basis, risk of entry on any one of the numerous man-made commodities that could harbor a hibernating queen is likely to be very low as the concentration of the organism on this pathway at origin is likely to be very low. However, given the sheer number of commodities (and potential routes of entry that exist, overall probability of entry of a hibernating queen is high. Pathway 5. Entry with imported fruits and flowers is also considered to be comparatively important, given that this pathway is known to have brought in live (queen?) Oriental hornets. As stated above, since *V. velutina* is not currently classed as a quarantine plant or tree pest or disease, so on those occasions when controlled imports are inspected it's presence may not necessarily be noted. Pathways 4., and 6. Entry with soil or on transport vehicles are both considered to be comparatively less important. Hibernation in soil is comparatively rare. Although hitch-hiking on transport vehicles is possible, there are no records of hornets of any species being transported in this way. Pathway 7. Entry with honey bee imports is considered highly unlikely (i.e. comparatively unimportant). Asian hornets rarely enter honey bee colonies – the likelihood that they could be imported in this way without detection is also extremely low.
Summarise Establishment	**Very likely – 4**	**Low – 0**	The Asian hornet *V. velutina* is very likely to establish in the Risk Assessment area. This species has readily established in

			France in areas that share the ecoclimatic conditions found in at least parts of the UK. It is highly adaptable, and is capable of colonizing urban, sub-urban, agricultural and wooded areas. Suitable food species for survival development and multiplication are abundant and widespread – there are in excess of 130,000 colonies of honey bees in England, Scotland, Wales and N. Ireland, and numerous other alternative unmanaged sources of wild insect prey (flies, crickets, caterpillars etc.) are available. The likely effect(s) of indigenous natural enemies on the establishment of Asian hornets in the Risk assessment area is unknown, but their presence has not prevented establishment in France and Spain. There is good molecular evidence that the population of *V. velutina nigrothorax* present in France, and now Spain, originated from just one mated female, so a single incursion by a queen hornet into the UK could be sufficient for establishment.
Summarise Spread	**Rapid – 4**	**Low – 0**	The Asian hornet *V. velutina* is likely to spread rapidly in the Risk Assessment area. It was first introduced into France in 2003/2004, and by 2010 the Asian hornet was already present in 39 French départements and had entered Spain. Adult hornets are highly mobile and, to date, efforts to contain it have been unsuccessful.
Summarise Impacts	**Moderate – 2**	**Medium – 1**	Repeated and sometimes severe attacks from *V. velutina* on French honey bee colonies were reported in 2006 and 2007. The primary effect of predation by Asian hornets is death of adult worker honey bees, but they will also take brood and honey reserves. Asian hornets also have indirect effects on honey bee health: French *A. mellifera* colonies predated by *V. velutina* are typically left very weak, low in foragers or queenless, and vulnerable to disease, infestation and robbing. Honey bees are the major managed pollinator in the UK. Certain crops such as apples are heavily reliant on this type of commercial pollination, and without honey bees or a replacement pollinator, yields would be reduced. Honey

			production is dependant on a healthy honey bee population, which would clearly be effected in the event that bee numbers decline. Asian hornets pose additional risks to unmanaged pollinators, such as bumble bees, likely to have a further negative effect on crop production. Hornets also pose a threat to ripe fruit, which they may damage. The *perceived* threat to people posed by Asian hornets (real or imagined) may result in a level of public nuisance – fear of a fairly conspicuous, potentially aggressive and venomous exotic species has already led to some coverage in the popular press. Although described as a "serious pest of honey bees" in available literature, assessments of the exact economic impact of *V. velutina* in its existing geographical range are lacking. While the actual effect on honey bee colonies is as yet unmeasured, the financial implications of the arrival of *V. velutina* in the UK are difficult to assess. Equally, until more is known about effects on unmanaged wild insect populations, uncertainty re. it's likely ecological impact is very high.
Conclusion of the risk assessment	**Medium – 1**	**Medium – 1**	There are multiple Pathways by which the Asian hornet, *V. velutina*, could enter the Risk Assessment area. In particular, inseminated queens, each capable of founding an entire colony, are likely or very likely to survive on imports of untreated timber, soil, or any other substrates providing suitable harborages for hibernation (ceramic pots being a case in point). Given the wide range of commodities and Pathways involved, it is unlikely that it will be possible to intercept all potential incursions. The arrival of *V. velutina* in the UK is highly likely. The Asian hornet is *V. velutina* is not classed as a quarantine plant or tree pest or disease. This means that even if it is detected as part of a formal Inspection (e.g. PHSI inspection of fruit) there is currently no onus on it's recognition or destruction.

			The experiences of French beekeepers demonstrate that Asian hornets are very likely to establish and spread rapidly in the UK: suitable prey (managed honey bees and wild indigenous invertebrates) and habitats are widespread across UK. Potential for establishment may be relatively greater in the following areas: (i) Areas where winters are milder (southern English counties); open areas near water; near ports and airports, where controlled and uncontrolled consignments of imported commodities that may harbour overwintering queens are most likely to enter; in the event that *V. velutina* crosses the English Channel, either on shipping or by natural spread, coastal counties of southern England will be most at risk. There is an urgent need to obtain reliable quantitative data re. the economic impact of *V. velutina* in the EU and it's native range. In the absence such data the potential impact on UK beekeeping and, in turn, pollination and honey production, is very difficult to assess. However, reports from France that the direct impact on honey bee colonies can, at least on some occasions be marked; indirect effects (chronic debilitation of raided colonies), although less apparent, could have more serious impact long term.
Conclusions on Uncertainty		**Medium – 1**	This risk assessment is based on available scientific literature relating to existing populations of *V. velutina* in it's native range and in France, where it has recently become established. No literature is yet available regarding biology/behaviou/impact of *V. velutina* in Spain. There is low uncertainty about it's likelihood of arrival in the UK, and very low uncertainty about it's likelihood of rapid establishment and spread. There is high uncertainty about its likely impact, both economic and environmental, due to a lack of reliable quantitative data re. the impact of *V. velutina* in the EU and it's native range.

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