RISK ASSESSMENT COVERING PAGE - ABOUT THE PROCESS

It is important that policy decisions and action within Great Britain are underpinned by evidence. At the same time it is not always possible to have complete scientific certainty before taking action. To determine the evidence base and manage uncertainty a process of risk analysis is used.

Risk analysis comprises three component parts: risk assessment (determining the severity and likelihood of a hazard occurring); risk management (the practicalities of reducing the risk); and risk communication (interpreting the results of the analysis and explaining them clearly). This tool relates to risk assessment only. The Non-native Species Secretariat manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. During this process risk assessments are:

- Commissioned using a consistent template to ensure the full range of issues is addressed and maintain comparable quality of risk and confidence scoring supported by appropriate evidence.
- Drafted by an independent expert in the species and peer reviewed by a different expert.
- Approved by the NNRAP (an independent risk analysis panel) only when they are satisfied the assessment is fit-for-purpose.
- Approved 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 and GB Programme Board if necessary.

Common misconceptions about risk assessments

The risk assessments:

- Consider only the risks (i.e. the chance and severity of a hazard occurring) posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They also only consider only the negative impacts of the species, they do not consider any positive effects. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Are advisory and therefore part of the suite of information on which policy decisions are based.
- Are not final and absolute. They are an assessment based on the evidence available at that time. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

Period for comment

Once placed on the NNSS website, risk assessments are open for stakeholders to provide comment on the scientific evidence which underpins them for three months. Relevant comments are collated by the NNSS and sent to the risk assessor for them to consider and, if necessary, amend the risk assessment. Where significant comments are received the NNRAP will determine whether the final risk assessment suitably takes into account the comments provided.

To find out more: published risk assessments and more information can be found at https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=22

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: ***Callosciurus erythraeus***
Author: Maria Vittoria Mazzamuto, Lucas Wauters, Adriano Martinoli, Sandro Bertolino
Risk Assessment Area: European Union (28 Countries)

Draft: 05/12/2014

EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	France, The Netherlands, Belgium, Italy
2. In how many EU member states has this species currently established populations? List them.	France, The Netherlands, Belgium, Italy
3. In how many EU member states has this species shown signs of invasiveness? List them.	France, The Netherlands, Belgium, Italy
4. In which EU Biogeographic areas could this species establish?	Continental area, probably Mediterranean area
5. In how many EU Member States could this species establish in the future [given current climate] (including those where it is already established)? List them.	The species is established in Italy, France, Belgium, The Netherland. It probably also adapt to climatic condition present in Austria, Croatia, Czech Republic, Germany, Hungary, Luxembourg, Malta, Poland, Romania, Slovakia, Slovenia, Spain,.
6. In how many EU member states could this species become invasive in the future [given current climate] (where it is not already established)?	The species could become invasive in most of Europe, if established, mainly for the possibility to reduce population size or even replace the native red squirrel that is the only native tree squirrel present in Europe. The confidence of this prediction is higher in parts of Europe where mixed broadleaves forests are dominant and lower for areas where conifers are dominant.

SECTION A – Organism Information and Screening		
Stage 1. Organism Information	**RESPONSE [chose one entry, delete all others]**	**COMMENT**
1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	*Callosciurus erythraeus* Pallas, 1779. EN: Pallas's squirrel (red-bellied tree squirrel); FR: ecureuil à ventre rouge (ecureuil de Pallas, ecureuil de Formose); IT: scoiattolo di Pallas; DE: Pallas-hörnchen	Yes, this species can be adequately distinguished from other entities of the same rank
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	NA	
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	No	A Risk Assessment has been conducted in Belgium and The Netherlands and the result was that the species has high potential of establishment and dispersal in those countries.
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	No	They only consider single countries.
5. Where is the organism native?		South East Asia
6. What is the global distribution of the organism (excluding Europe)?		The species is native to the north-eastern part of South Asia: it is widely distributed in central and southern China (Smith & Xie 2008), and mainland Southeast Asia (Duckworth et al. 2008a). The countries concerned are: Bangladesh, north-eastern India (Molur et al. 2005), Myanmar, northern Thailand, Laos, southern and northern Vietnam, eastern Cambodia, Peninsular Malaysia and Taiwan (Moore & Tate 1965, Wilson & Reeder 2005, Duckworth et al. 2008a, Bertolino & Lurz 2013).

		Pallas's squirrels have been introduced to five localities of Argentina (Guichón et al. 2005, Benitez et al. 2010, Bertolino & Lurz 2013) and in at least 13 areas in Japan (1 area eradicated) (Abe et al. 2005, Ikeda et al. 2011), and to Hong Kong (2 known populations) (Ho 1994, Chung & Corlett 2006).
7. What is the distribution of the organism in Europe?		Southern France (Gurnell & Wauters 1998; Duff & Lawson 2004; Chapuis et al. 2011), a small area in south-east of The Netherlands close to Belgium border (Dijkstra et al. 2009) and north of Italy (Bertolino & Lurz 2013). In Belgium one of the two populations of the species has been eradicated (Stuyck et al. 2009) while a limited number of animals occur near Bree-Bocholt close to Dutch border and near the Dutch population (Schockert 2012).
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes	The most evident damage caused by Pallas's squirrels is bark stripping, especially where and when food availability is weak (Guo et al. 2011): it can be really important as reported in France (Jouanin 1986), Argentina (Guichón & Doncaster, 2008) and Japan (Tamura & Ohara 2005). Bark stripping increases the risk of fungal infections and invertebrate damage, which can reduce timber yield (Mayle 2010). Another impact of *C. erythraeus* may be linked to the use of leaves, branches and bark to build its nests. Some potential problems of predation on native fauna have been mentioned in Argentina and Japan where predation on eggs was observed (Pereira et al. 2003; Guichón et al. 2005, 2009; Azuma 1998) but further studies are required. Unpublished data from North Italy suggest that interspecific competition with the native red squirrel occurs

		resulting in reduced density or even disappearance of the native species (Mazzamuto unpubl. data)
9. Describe any known socio-economic benefits of the organism in the risk assessment area.	None known	
Stage 2. Screening Questions		
10. Has this risk assessment been requested by the Programme Board? (If uncertain check with the Non-native Species Secretariat)	NA	
11. What is the reason for performing the risk assessment?	Identification of invasive alien species of EU concern	
12. Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		Tree squirrels are highly adaptive and opportunistic species and viable populations could establish from few founders. The likelihood ratio for a couple of *Callosciurus* spp. (*C. erythraeus and C. finlaysonii* the introduced species considered) to successfully establish a viable population is 73% and a likelihood ratio of 90% is achieved with >4 animals (Bertolino 2009). The number of yearly litters is from 1 to 3 if the mast production (food supply) is high, with an average of 1.4 weaned offspring (Tamura et al. 1989; Dijkstra, com. pers.). Few studies of dispersal distances are available for this squirrel species, but it is usually considered that the maximum dispersal distance is about 5 km (Lin & Yo 1981, Guichón & Doncaster 2008). The species lives in deciduous, mixed and coniferous woodland habitats (Chapuis et al. 2011, Dijkstra & Dekker 2008, Dijkstra et al. 2009) feeding on tree seeds and a variety of other foods (tree flowers, buds, mushrooms, berries, occasionally insects and bird eggs; they may sometimes feed on cereals). The species is also

		found in suburban areas where it benefits from supplemental feeding (Bertolino & Lurz 2013).
13. Does the organism occur outside effective containment in Europe?	Yes	
14. Is the organism widely distributed in Europe?	Yes	Pallas's squirrel populations are present in France (Chapuis & Menigaux 2010), The Netherlands (Dijkstra 2010), Italy (Martinoli et al. 2010), and Belgium (Schockert 2012).
15. Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in Europe, in the open, in protected conditions or both?	Yes	The species is found in deciduous and mixed forest and in urban parks (open); it is also present in zoological gardens and as a pet in private houses and parks (protected conditions).
16. Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?	No	
17. Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in Europe or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.	NA	
18. Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of EU or sufficiently similar for the organism to survive and thrive?	Yes	If they initially originate from tropical and subtropical broadleaf forests, due to their flexibility, they were also able to colonize warm temperate environments (Setoguchi 1990; Sheng et al. 1999) as well as subalpine broadleaf and coniferous forests until 3000 m of altitude (Smith & Xie 2008), but it seems they were not able to

		colonize the northern deciduous forests with harsh winter conditions (i.e. large snow precipitations and a mean temperature of coldest months lower than -4°C) (Setoguchi 1990, Bertolino 2009). Frost sensitivity of the Pallas's squirrel is likely to reduce its establishment capacity but the Dutch climate fully matches with the species requirements (Dijkstra & Dekker 2008).
19. Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe?	Yes	The species is present in zoological gardens and private collections.
20. Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	Yes	The species has been introduced to many localities of Japan (from years 1930s), Argentina (from 1970) and Hong Kong (1972) establishing viable populations. In Europe, Pallas's squirrel was introduced in Southern France at the end of the 1960s, while in The Netherlands (3 populations), Italy (1 population) and Belgium (two populations, one eradicated) the populations reported are quite recent (from 1998 onwards) (Bertolino & Lurz 2013).
21. Can the organism spread rapidly by natural means or by human assistance?	Yes	Good natural dispersal capacity (Lin & Yo 1981; Guichón & Doncaster 2008). Humans can further promote the spread of the species with translocation from one area to another (Shorten 1954; Guichón et al. 2005; Martinoli et al. 2010).
22. Could the organism as such, or acting as a vector, cause economic, environmental or social harm in Europe?	Yes	In its native area *C. erythraeus* is considered as a tropical crop pest (Hill 2008). It causes damages in fruit trees and crop plantations, eating and spoiling the fruits which are eaten as well as the green parts of coveted plants and significant economic impacts in the native range have been pointed out in many publications (especially on conifer plantations; Lin & Yo 1981; Kuo 1982; Tsui et al. 1982).

		In the new recipient areas, the most evident damage caused by this species is also bark stripping (especially where and when food availability is weak, Guo et al. 2011) with substantial economic loss of profit in tree plantations (Jouanin 1992, Stuyck et al. 2009); damage can be really important as reported in France (Chapuis & Menigaux 2010), Argentina (Guichón et al. 2009) and Japan (Tamura & Ohara 2005). In Argentina the consumption of cereals in storage silos is also reported (Guichón et al. 2009, Bertolino & Lurz 2013). However most of the data are qualitative and don't enable us to assess the quantitative losses caused by the Pallas's squirrel (Bertolino & Lurz 2013). Another impact of C. erythraeus may be linked to the use of leaves, branches and bark to build its nests. The species is also considered as a pest because of damages caused in gardens and plantations (bark stripping of trees and shrubs, fruit consumption especially in olive and citrus plantations and in orchards) and damages to infrastructures like telephonic cables, sprinkler systems, etc. In Argentina, such problems of deterioration of lighting, television and telephonic cables have also been reported (Dijkstra et al. 2009; Guichón et al. 2005, 2009; Chapuis & Menigaux 2010). Thus, nowadays, in France part of the citizens call it "Korean rat" (Chapuis et al. 2011). Competition with native species like the red squirrel (*Sciurus vulgaris*) is also considered a strong potential impact (Chapuis et al. 2011; Mazzamuto unpub. data) and transmission of pathogens could likely cause a risk but, currently, it is not documented enough.

SECTION B – Detailed assessment

PROBABILITY OF ENTRY

Important instructions:

- Entry is the introduction of an organism into Europe. Not to be confused with spread, the movement of an organism within Europe.
- For organisms which are already present in Europe, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.

QUESTION	RESPONSE [chose one entry, delete all others]	CONFIDENCE [chose one entry, delete all others]	COMMENT
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	few	very high	The species is already present in the Risk Assessment area with viable and spreading populations in four countries. The pathway for new introduction is escapes from pet owners, deliberate release from pet owners, deliberate introductions.
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).	[Pet-trade]		The primary pathway for entry involves their escape or deliberate release from captivity. The origin of the pathway is considered to be the keeping of the animals in captivity but also deliberate introductions in parks and woods. Likelihood of association is considered to remain high as long as the species continues to be kept in captivity and sold by pet shops (Bertolino 2009). Natural populations could be the source of animals for an illegal trade of the species (Signorile et al. 2014b).
Pathway name:	[Pet-trade]		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)?	intentional	very high	The species is intentionally imported and traded in many European countries (UNEP-WCMC 2010). The animals may then be released or escape.

(If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)			
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	moderately likely	medium	Trade statistics are not available. An internet survey conducted in November 2010, in order to investigate whether the species appears to be traded within the EU, and whether there appears to be demand for this species as a pet, found adverts for the sale of Pallas's squirrels on Danish and Swedish websites; there were several advertisements for people wanting 'squirrels' in German and Swedish websites (UNEP-WCMC 2010).
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	very likely	high	Natural populations can establish from few founders and grow quickly (Shorten 1954; Bertolino 2009; Wood et al. 2007). The species is often released in urban parks, suburban gardens, parkland, etc., which could provide suitable habitats with supplemental feeding from humans (Bertolino et al. 2004; Bonnington et al. 2014a,b), and from here spread to forested habitats (deciduous, mixed and coniferous woodland) (Miyamoto et al. 2004; Guichón et al. 2005).
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	likely	high	The species is already present in Italy, France, Belgium and The Netherlands and is traded in many others.
End of pathway assessment, repeat as necessary.			
1.11. Estimate the overall likelihood of entry into Europe based on all pathways (comment on the key issues that lead to this conclusion).	likely	high	The principal pathway for entry is escape or release from captivity. The origin of the pathway is considered to be the keeping of the animals in captivity but also deliberate introductions in parks and woods. Likelihood of association is considered to remain high as long as the species continues to be kept in captivity and sold by pet shops (Bertolino 2009). Natural populations could be the source of animals for an illegal trade of the species (Signorile et al. 2014b). In Italy a Decree signed on 24th December 2013 forbids trading, raising and keeping of Pallas's squirrel and two

			other squirrel species (*Sciurus niger*, *Sciurus carolinensis*). In The Netherlands there is the prohibition of trading and keeping the same three species since July 2012. In Belgium with the Royal Decree of 16th July 2009 *C. erythraeus* has not been included in the short positive list of mammal species that may be held by private people. This, however, does not stop the movements of animals within Europe where the species is already sold in some countries (UNEP-WCMC 2010).

PROBABILITY OF ESTABLISHMENT

Important instructions:

- For organisms which are already well established in Europe, only complete questions 1.15 and 1.21 then move onto the spread section. If uncertain, check with the Non-native Species Secretariat.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
1.12. How likely is it that the organism will be able to establish in Europe based on the similarity between climatic conditions in Europe and the organism's current distribution?	very likely	very high	The species already established in France, Belgium, The Netherlands and Italy (Bertolino & Lurz 2013). If they initially originate from tropical and subtropical climate, due to their flexibility, they are also able to colonize warm temperate environments (Chapuis et al. 2011; Bertolino & Lurz 2013). Dutch cold climate also fully matches with the species requirements (Dijkstra & Dekker 2008). For these reasons climatic conditions in most of Europe is considered suitable for Pallas's squirrels.
1.13. How likely is it that the organism will be able to establish in Europe based on the similarity between other abiotic conditions in Europe and the organism's current distribution?	very likely	very high	The species lives in deciduous, mixed and coniferous woodland habitats so all the temperate forests and woodlands in Europe have many tree species that provide food resources to the species; (sub)urban park populations occur both in Europe and in the native Asian range.
1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe? Subnote: gardens are not considered protected conditions	very likely	very high	The species is already keeps in wildlife parks, zoological gardens, private collections and pet shops.

1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	widespread	very high	The species lives in deciduous, mixed and coniferous woodland habitats, feeding on nuts, seeds, tree flowers, buds, mushrooms, berries, caterpillars, rarely on insects and bird eggs and sometimes on cereals. The species is also found in parks and towns. Therefore no single species is "vital" for its survival, development and multiplication. Suitable habitats are present and widely distributed in the Risk Assessment Area.
1.16. If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in Europe?	NA		
1.17. How likely is it that establishment will occur despite competition from existing species in Europe?	likely	high	There are some data indicating competition with the native red squirrel, but outcome seems in favour of the alien species (Chapuis et al. 2001; Mazzamuto unpub. data)
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in Europe?	very likely	high	A range of potential predators exist in Europe, these include raptors, red fox (*Vulpes vulpes*), stone and pine marten (*Martes* spp.), feral and domestic cats, and potentially owls. This suite of predators has not prevented the establishment, nor the spread of the animals were the species has been introduced in Europe.
1.19. How likely is the organism to establish despite existing management practices in Europe?	likely	high	In Belgium the species is not included in the short positive list of mammal species that may be held by private people and in The Netherlands and Italy there is the prohibition of trading and keeping the species. However, the species is still sold in other countries so a general wildlife management strategy in continental Europe is absolutely needed because all countries don't invest the same energy to prevent introductions of exotic species on their territory (Genovesi & Shine 2004). Just one population in Belgium has been eradicated while

			in The Netherlands, France and Italy eradication is still in progress. These management actions would stop the spread of established populations, but not the risk for Europe. The main pathway of entry is the pet trade and the risk of new introductions in other European countries continues to be present.
1.20. How likely are management practices in Europe to facilitate establishment?	NA		
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	moderately likely	medium	The dispersal potential of the species seems to be very limited, but it is also clear that established populations in Europe and South America originated from few animals (Wood et al. 2007, Bertolino 2009), thus proving the adaptability of *Callosciurus erythraeus* to new habitats, even if the colonization is slow and thus moderate (Dijkstra et al. 2009). Tree squirrels are generally considered as particularly adaptable because of their relatively high reproductive potential, wide food habits, and plasticity to anthropogenic habitats (Palmer et al. 2007, UNEP-WCMC 2010). Thus, prompt actions are recommended in any case of suspected invasiveness leading to possible impacts (Stuyck et al. 2009; Schockert 2012).
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?	very likely	high	The number of yearly litters is from 1 to 3 if the mast production (food supply) is high, with an average of 1.4 weaned offspring (Tamura et al. 1989; Dijkstra, com. pers.). The species has wide food habits and adaptability to new habitats (Bertolino & Lurz 2013).
1.23. How likely is the capacity to spread of the organism to facilitate its establishment?	likely	high	The dispersal capacity of juveniles away from their natal home range is considered to be lower than 5 km/year (Lin & Yo 1981, Guichón & Doncaster 2008). Bridgeman et al. (2012) consider *C. erythraeus* as able to cross some habitat gaps if

			the distance without connectivity is smaller than 100 m.
1.24. How likely is the adaptability of the organism to facilitate its establishment?	very likely	very high	The species could adapt to urban, suburban and more natural area, occurring in a variety of woodland habitat types
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?	likely	high	Pallas's squirrels have proven to be very successful invaders able to start new populations and spread even from few founders (Bertolino 2009; Schockert 2012).
1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in Europe? (If possible, specify the instances in the comments box.)	very likely	very high	25 out of 29 (86.2%) introductions outside the native range in Asia, South America, Europe were successful (Bertolino & Lurz 2013). The species already established in North (Belgium, The Netherlands) and South (France, Italy) Europe, showing its ability to adapt to European habitats.
1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in EU but is established because of continual release, is an example of a transient species.	unlikely	medium	If the species does not establish is probable that the introduced animals will disappear. However, the risk of new introductions will continue to remain.
1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).	likely	high	The species already established in North (Belgium, The Netherlands) and South (France, Italy) Europe. Climatic conditions in most of Europe are considered suitable for Pallas's squirrels (Chapuis et al. 2011; Bertolino & Lurz 2013; Dijkstra & Dekker 2008). If they initially originate from tropical and subtropical broadleaf forests, they were also able to colonize warm temperate environments (Setoguchi 1990, Sheng et al. 1999) as well as subalpine broadleaf and coniferous forests until 3000 m of altitude (Smith & Xie 2008) indicating a certain adaptability of the

			species. The species could adapt to urban, suburban and more natural area, occurring in a variety of woodland habitat types. Callosciurus erythraeus proven to be a very successful invader able to start new populations world-wide even from few founders (Bertolino 2009; Schockert 2012). Humans could help the spreading translocating them to new areas.

PROBABILITY OF SPREAD

Important notes:

- Spread is defined as the expansion of the geographical distribution of a pest within an area.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
2.1. How important is the expected spread of this organism in Europe by natural means? (Please list and comment on the mechanisms for natural spread.)	major	high	Active saturation dispersal, mainly of immature individuals, which will colonize new areas of suitable habitat. Quantitative studies are not reported for Europe but the mean areal expansion rate observed in Japan and Argentina varies between 6 and 22 km²/year and is known to increase after the establishment phase.
2.2. How important is the expected spread of this organism in Europe by human assistance? (Please list and comment on the mechanisms for human-assisted spread.)	major	high	Human assistance may amplify the potential of expansion of *C. erythraeus* by translocation. The main pathway of Pallas's Introductions in Europe has been connected to private citizens and animal traders who keep animals in captivity, with consequent risk of escape or release them into public estates and parks (Schockert 2012).
2.3. Within Europe, how difficult would it be to contain the organism?	difficult	medium	Likelihood is that it could be 'contained' where it doesn't spread over large areas, partly because of seasonally high trappability, and partly because of easy recognition of the species in new areas. However, practical difficulties likely to arise because of diverse landownership patterns likely to be encountered in typical release/escape areas and because of potential public opposition to control/eradication (Barr et al. 2002; Rushton et al. 2002).
2.4. Based on the answers to questions on the potential for	[Most of Europe]	high	See answers to questions 4 and 5 of EU CHAPPEAU

establishment and spread in Europe, define the area endangered by the organism.			
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of Europe were the species could establish), if any, has already been colonised by the organism?	0-10	high	
2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0-10	medium	Eradication programs are ongoing for all the colonies present in Italy, France, Belgium and Netherlands. If these management actions will not be effective a limited expansion is expected in next years.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Europe? (Please comment on why this timeframe is chosen.)	10	high	In 10 years the outcome of the eradication programs ongoing in the four countries will be clear
2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	0-10	medium	Depending on the results of the eradication programs
2.9. Estimate the overall potential for future spread for this organism in Europe (using the comment box to indicate any key issues).	moderately	medium	Few studies of dispersal distances are available for this squirrel species, but it is usually considered that the maximum dispersal distance is about 5 km (Lin & Yo 1981, Guichón & Doncaster 2008). In case of new introduction in other countries, the likelihood of establishment is high and the spread could be from slowly to moderate, depending on the habitat.

PROBABILITY OF IMPACT

Important instructions:

- When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment.
- Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section).
- Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in EUROPE separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.

QUESTION	RESPONSE	CONFIDENCE	COMMENTS
2.10. How great is the economic loss caused by the organism within its existing geographic range excluding Europe, including the cost of any current management?	major	high	In its native area *C. erythraeus* is considered as a tropical crop pest (Hill 2008). It causes damages in fruit trees and crop plantations, eating and spoiling the fruits which are eaten as well as the green parts of coveted plants and significant economic impacts in the native range have been pointed out in many publications (especially on conifer plantations; Lin & Yo 1981; Kuo 1982; Tsui et al. 1982). In the new recipient areas, the most evident damage caused by this species is also bark stripping (especially where and when food availability is weak, Guo et al. 2011) with substantial economic loss of profit in tree plantations; damage can be really important, though not quantified, as reported Argentina (Guichón et al. 2009) and Japan (Tamura & Ohara 2005). In Argentina the consumption of cereals in storage silos is also reported (Guichón et al. 2009, Bertolino & Lurz 2013). However most of the data are qualitative and don't enable us to assess the quantitative losses caused by the Pallas's squirrel (Bertolino & Lurz 2013). The species is also considered as a pest because of

			damages caused in gardens and plantations (bark stripping of trees and shrubs, fruit consumption especially in olive and citrus plantations and in orchards) and damages to infrastructures like telephonic cables, sprinkler systems, etc. In Argentina, such problems of deterioration of lighting, television and telephonic cables have also been reported (Guichón et al. 2005, 2009).
2.11. How great is the economic cost of the organism currently in Europe excluding management costs (include any past costs in your response)?	moderate	medium	In Europe the most evident damage caused by this species is bark stripping, with substantial economic loss of profit in tree plantations (Jouanin 1992, Stuyck et al. 2009); damage can be really important as reported in France (Chapuis & Menigaux 2010), though not quantified. However most of the data are qualitative and don't enable us to assess the quantitative losses caused by the Pallas's squirrel (Bertolino & Lurz 2013). The species is also considered as a pest because of damages caused in gardens and plantations (bark stripping of trees and shrubs, fruit consumption especially in olive and citrus plantations and in orchards) and damages to infrastructures like telephonic cables, sprinkler systems, etc. (Dijkstra et al. 2009; Chapuis & Menigaux 2010).
2.12. How great is the economic cost of the organism likely to be in the future in Europe excluding management costs?	moderate	low	If the species is not eradicated or if it establish in other areas, damage reported in point 2.11 should be probably moderate, but is some are they could be major. Since available data are limited there is a high incertitude in these predictions.
2.13. How great are the economic costs associated with managing this organism currently in Europe (include any past costs in your response)?	major	medium	Eradication programs are ongoing in four countries, manly by means of live trapping and euthanasia or keeping animals in captivity. Cost evaluation of these management actions are not yet available, but considering previous eradication programs on other species they should be high.

2.14. How great are the economic costs associated with managing this organism likely to be in the future in Europe?	moderate	low	Eradication programs are ongoing and therefore costs associated will still be present. If the species is not banned from Europe, the possibility of new introductions is high and therefore further management actions will be needed.
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding Europe?	major	high	In its native area *C. erythraeus* is considered as a tropical crop pest (Hill 2008). It causes damages in fruit trees and crop plantations, especially in oil palm, papaya and cocoa trees, eating and spoiling the fruits which are eaten as well as the green parts of coveted plants. In Japan and Argentina the most evident damage caused by this species is bark stripping (especially where and when food availability is weak (Guo et al. 2011)) with substantial economic loss of profit in tree plantations (Tamura & Ohara 2005; Guichón et al. 2009). In Argentina the consumption of cereals in storage silos, damages to infrastructures like telephonic and television cables, sprinkler systems have also been reported (Guichón et al. 2005, 2009). In Japan the Pallas's squirrel could have an impact on the native squirrel species, *Sciurus lis*, that is locally declining (Ministry of the Environment, Japan, 2002; Hori et al. 2006).
2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) currently in Europe (include any past impact in your response)?	major	high	The activity of bark stripping typical of the species increases the risk of fungal infections and invertebrate damage with an influence on the flora and fauna associated with specific woodland types. Another impact may be linked to the use of leaves, branches and bark to build its nests. There are some potential problems of predation on bird eggs (Pereira et al. 2003; Guichón et al. 2005, 2009; Azuma 1998) but further studies are required on whether they contribute to the decline of particular woodland bird species in Europe.

			Competition with native species like *Sciurus vulgaris* is also considered a strong potential impact (Chapuis et al. 2011; Mazzamuto unpubl. data) and transmission of pathogens could likely cause a risk but, currently, it is not documented enough.
2.17. How important is the impact of the organism on biodiversity likely to be in the future in Europe?	major	high	If uncontrolled, the spread of the Pallas's squirrel from Italy to France and Switzerland, and in the long term to other European countries, or the direct introduction of the species to other countries, could probably affect the native red squirrel.
2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism currently in Europe (include any past impact in your response)?	moderate	medium	Bark stripping could influence woodland management practices, with a shift away from trees susceptible to squirrel damage (Mayle, 2005), with an influence on the flora and fauna associated with specific woodland types.
2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism likely to be in Europe in the future?	moderate	low	Bark stripping could influence woodland management practices (Mayle, 2005); its impact, however, will depend on the results of the eradication programs. In case of introductions of the species in other countries woodland damage and alteration will depends on local management practices.
2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism currently in Europe?	moderate	high	Though not included in the Habitat Directive, the extinction of the red squirrel with its replacement by the Pallas's squirrel decreases the conservation status of many areas.
2.21. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism likely to be in the future in Europe?	moderate	high	A decrease in the conservation status of many areas is expected if the red squirrel will be replaced by the Pallas's squirrel in other parts of France, Belgium, Netherlands and Italy and possibly in new areas of introduction.
2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic,	NA		

environmental or social effects more serious?			
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	minimal	low	Not known
2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	minimal	low	Transmission of pathogens could likely be a risk but, currently, it is not documented enough.
2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment box)	minimal	low	Not known
2.26. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Europe?	major	medium	Predation is only rarely a cause of mortality in Pallas's squirrel populations (Tamura et al. 1989; Chapuis 2011; Schockert 2012). Parasites and pathogens present in Belgium, France, Netherlands and Italy do not limit the species (Dozières et al. 2010).
2.27. Indicate any parts of Europe where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	Depends on eradication outcomes and/or new introductions]	medium	Italy, France, Belgium, The Netherlands if eradication projects will not be effective. In other countries in the Continental and Mediterranean biogeographic areas if the species will be introduced.

RISK SUMMARIES

	RESPONSE	CONFIDENCE	COMMENT
Summarise Entry	very likely	high	The species is already present in the Risk Assessment area in Italy, France, Belgium and The Netherlands with viable populations (Bertolino & Lurz 2013). The primary pathway for entry involves their escape or deliberate release from captivity. The origin of the pathway is considered to be the keeping of the animals in captivity but also deliberate introductions in parks and woods. The species is still intentionally imported and traded in many European countries (UNEP-WCMC 2010) and is already keeps in wildlife parks, zoological gardens, private collections and pet shops.
Summarise Establishment	very likely	high	The species already established in France, Belgium, The Netherlands and Italy (Bertolino & Lurz 2013). If they initially originate from tropical and subtropical climate, due to their flexibility, they are also able to colonize warm temperate environments (Chapuis et al. 2011; Bertolino & Lurz 2013). Dutch cold climate also fully matches with the species requirements (Dijkstra & Dekker 2008). For these reasons climatic conditions in most of Europe is considered suitable for Pallas's squirrels. The species lives in deciduous, mixed and coniferous woodland habitats so all the temperate forests and woodlands in Europe have many tree species that provide food resources to the species; (sub)urban park populations occur both in Europe and in the native Asian range.
Summarise Spread	moderately	medium	Eradication programs are ongoing for all the colonies present in Italy, France, Belgium and Netherlands. If these management actions will not be effective an

			expansion is expected in next years. In case of new introduction in other countries, the likelihood of establishment is high and the spread could be from slowly to moderate, depending on the habitat. Active saturation dispersal, mainly of immature individuals, which will colonize new areas of suitable habitat. Quantitative studies are not reported for Europe but the mean areal expansion rate observed in Japan and Argentina varies between 6 and 22 km²/year and is known to increase after the establishment phase. Human assistance may amplify the potential of expansion of *C. erythraeus* by translocation
Summarise Impact	major	medium	The magnitude of present and future impacts will depends on the results of ongoing management activities and the possible establishment of new populations The most evident damage caused by Pallas's squirrels is bark stripping, especially where and when food availability is weak (Guo et al. 2011): it can be really important as reported in France (Jouanin 1986), Argentina (Guichón & Doncaster, 2008) and Japan (Tamura & Ohara 2005). Bark stripping increases the risk of fungal infections and invertebrate damage, which can reduce timber yield (Mayle 2010). Another impact of *C. erythraeus* may be linked to the use of leaves, branches and bark to build its nests. Some potential problems of predation on native fauna have been mentioned in Argentina and Japan where predation on eggs was observed (Pereira et al. 2003; Guichón et al. 2005, 2009; Azuma 1998) but further studies are required. Unpublished data from North Italy suggest that interspecific competition with the native red squirrel occurs resulting in reduced density or even disappearance of the native species (Mazzamuto unpubl. data).

Conclusion of the risk assessment	high	medium	A large number of scientific publications demonstrate the invasiveness of *Callosciurus erythraeus* in terms of establishment probabilities and damage to forestry and plantations. Data on the possible impacts on native species (e.g. predation or competition) are scanty though preliminary results of ongoing research suggest that interspecific competition with the native red squirrel occurs resulting in reduced density or even disappearance of the native species (Mazzamuto unpubl. data).

Additional questions are on the following page ...

ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	[climate directly]	high	*Callosciurus erythraues* initially originate from tropical and subtropical broadleaf forests, due to their flexibility, they were also able to colonize warm temperate environments (Setoguchi 1990; Sheng et al. 1999) as well as subalpine broadleaf and coniferous forests until 3000 m of altitude (Smith & Xie 2008), but it seems they were not able to colonize the northern deciduous forests with harsh winter conditions (i.e. large snow precipitations and a mean temperature of coldest months lower than -4°C) (Setoguchi 1990, Bertolino 2009). Frost sensitivity of the Pallas's squirrel is likely to reduce its establishment capacity but the Dutch climate fully matches with the species requirements (Dijkstra & Dekker 2008). Considering that warmer and drier conditions seem to favour the spread of the species, the present climate change may further benefit the species in colonising new areas.
3.2. What is the likely timeframe for such changes?	50 - 100 years	medium	
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	[Increase suitability of some habitats]	medium	
ADDITIONAL QUESTIONS - RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	[The impact to native fauna should be further investigated]	medium	Confidence in the risk assessment is high for establishment, spread and damage to forestry and plantations. Data on the possible impacts on native species are scanty though preliminary results suggest a possible competition with the native red squirrel; there

			are also occasional reports of bird eggs predation. The impacts on native species should be further investigated to better evaluate the level of invasiveness of the species. The outcomes of the ongoing eradication programs should be published to better evaluate costs and effectiveness of these management actions.

Please provide a reference list on the following page ...

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RISK ASSESSMENT COVERING PAGE - ABOUT THE PROCESS

It is important that policy decisions and action within Europe are underpinned by evidence. At the same time it is not always possible to have complete scientific certainty before taking action. To determine the evidence base and manage uncertainty a process of risk analysis is used.

Risk analysis comprises three component parts: risk assessment (determining the severity and likelihood of a hazard occurring); risk management (the practicalities of reducing the risk); and risk communication (interpreting the results of the analysis and explaining them clearly). This tool relates to risk assessment only. The Non-native Species Secretariat manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. During this process risk assessments are:

- Commissioned using a consistent template to ensure the full range of issues is addressed and maintain comparable quality of risk and confidence scoring supported by appropriate evidence.
- Drafted by an independent expert in the species and peer reviewed by a different expert.
- Approved by the NNRAP (an independent risk analysis panel) only when they are satisfied the assessment is fit-for-purpose.
- Approved 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 and GB Programme Board if necessary.

Common misconceptions about risk assessments

The risk assessments:

- Consider only the risks (i.e. the chance and severity of a hazard occurring) posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They also only consider only the negative impacts of the species, they do not consider any positive effects. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Are advisory and therefore part of the suite of information on which policy decisions are based.
- Are not final and absolute. They are an assessment based on the evidence available at that time. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

Period for comment

Once placed on the NNSS website, risk assessments are open for stakeholders to provide comment on the scientific evidence which underpins them for three months. Relevant comments are collated by the NNSS and sent to the risk assessor for them to consider and, if necessary, amend the risk assessment. Where significant comments are received the NNRAP will determine whether the final risk assessment suitably takes into account the comments provided.

To find out more: published risk assessments and more information can be found at https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=22

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: ***Myocastor coypus***
Author: Sandro Bertolino
Risk Assessment Area: European Union (28 Countries)

Draft: 05/12/2014

EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Netherlands, Norway, Poland, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom (Map in DAISIE website)
2. In how many EU member states has this species currently established populations? List them.	Austria, Belgium, Bulgaria, Croatia, France, Germany, Greece, Italy, Luxembourg, Netherlands, Romania, Slovakia, Slovenia, Spain (Map in DAISIE website). Eradicated from United Kingdom (Gosling & Baker 1989)
3. In how many EU member states has this species shown signs of invasiveness? List them.	It is invasive in Italy, France and Central Europe
4. In which EU Biogeographic areas could this species establish?	According to present distribution the species is already established in the Atlantic, Continental, Mediterranean, Pannonian (?), Biogeographic areas; the establishement in the other Biogeographic areas is not likely
5. In how many EU Member States could this species establish in the future [given current climate] (including those where it is already established)? List them.	Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Switzerland, United Kingdom
6. In how many EU member states could this species become invasive in the future [given current climate] (where it is not already established)?	Spain and Portugal; in Great Britain it was invasive in the past, but it has been eradicated.

SECTION A – Organism Information and Screening		
Stage 1. Organism Information	**RESPONSE [chose one entry, delete all others]**	**COMMENT**
1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	*Myocastor coypus* Molina, 1782. EN: Coypu; FR: Ragondin; IT: Nutria; D: Nutria; ES: Coipú	Yes, this species can be adequately distinguished from other entities.
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	NA	
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	No	
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	NA	
5. Where is the organism native?		South America
6. What is the global distribution of the organism (excluding Europe)?		Coypus are native from South America where they are present in Argentina, Bolivia, Brazil, Chile, Paraguay, Uruguay. Coypu populations are currently established in North America, Central and Eastern Asia including Japan and Korea, Kenya in East Africa, and the Middle East (Carter & Leonard 2002; Bertolino et al. 2012).
7. What is the distribution of the organism in Europe?		Austria, Belgium, Bulgaria, Croatia, France, Germany, Greece, Italy, Luxembourg, Netherlands, Romania, Slovakia, Slovenia, Spain (DAISIE website).
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems)	Yes	Coypus have been introduced and established population in many localities of Europe, North

anywhere in the world?		America, Central and Eastern Asia including Japan and Korea, Kenya in East Africa, and the Middle East (Carter & Leonard 2002; Bertolino et al. 2012). It has been included in the IUCN list of the 100 of the worst invasive species (Bertolino 2009). Coypus are generalist herbivores, which feed on a wide variety of plant materials, including leaves, stems and roots. As a result of this feeding activity, large areas of *Nuphar lutea*, *Rumex* spp., *Sagittaria* spp., *Scirpus* spp., *Phragmites australis*, *Trapa natans*, *Typha* spp., may be eliminated (Ellis 1963; Willner et al. 1979; Boorman & Fuller 1981; Bertolino et al. 2005). Occasionally, coypus might feed on crustaceans and freshwater mussels, but prey are important only locally. In Louisiana (USA) the coypu exerts an important impact on the aboveground biomass of native marsh plant species, such as chairmaker's bulrush, *Scirpus americanus* (Johnson and Foote, 1997) and arrowheads, *Sagittaria latifolia* and *S. platyphylla* (Llewellyn & Shaffer 1993). In Louisiana and Maryland feeding activity of coypu has been associated with the loss of brackish and freshwater marshes through a process known as eatout (Foote & Johnson 1993; Carter et al. 1999). In 2007, estimates of coastwide marsh damaged by coypu feeding activity ranged from 3,400 to 41,500 hectares per year (Louisiana Department of Wildlife and Fisheries 2007). Coypus could impact waterbird breeding success by using their nests as platform for resting and thus crushing or sinking the eggs (Bertolino et al. 2011; Angelici et al. 2012). Competitive exclusion may be taking place between coypu and the muskrat *Ondatra zibethicus* in North America

		(Bertolino et al. 2012).
9. Describe any known socio-economic benefits of the organism in the risk assessment area.	None known	
Stage 2. Screening Questions		
10. Has this risk assessment been requested by the Programme Board? (If uncertain check with the Non-native Species Secretariat)	No	
11. What is the reason for performing the risk assessment?	Identification of invasive alien species of EU concern	
12. Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		Coypus can breed throughout the year. The age of first parturition is 3-8 months. Prenatal embryo losses (up to 50-60%) and abortion of litters could influence productivity. Mean litter size at birth is 4.5-5.4 (Italy, England). In favourable habitats, females may have 2.7 litters/year with a mean of 15 young/year (Gosling 1981). On average, individuals in introduced populations put on weight more quickly, they reach sexual maturity at a younger age and frequently live at higher population densities than in their native range (Guichón et al. 2003; Bertolino et al. 2012). This may be related to a high hunting pressure in the native range,which selects for smaller adult size with respect to introduced areas (Purvis 2001); though it may also be explained by harsh climatic conditions in introduced ranges that favour heaviness animals. Coypus are found in a variety of aquatic habitats including: wetlands, ponds, lakes, rivers and streams. In these habitats, the species could affect vegetation and aquatic birds.

13. Does the organism occur outside effective containment in Europe?	Yes	
14. Is the organism widely distributed in Europe?	Yes	Established populations are present in Austria, Belgium, Bulgaria, Croatia, France, Germany, Greece, Italy, Luxembourg, Netherlands, Romania, Slovakia, Slovenia, Spain.
15. Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in Europe, in the open, in protected conditions or both?	Yes	The species is found in a variety of aquatic habitats such as wetlands, ponds, lakes, rivers and streams, even in urban areas; it is also present in some zoological gardens.
16. Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?	No	
17. Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in Europe or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.	NA	
18. Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of Europe or sufficiently similar for the organism to survive and thrive?	Yes	The species is already established in many European countries; therefore climatic conditions in most of Europe are considered almost suitable for coypu. Anyway, coypu populations are sensitive to climatic conditions and severe winters may be the most limiting factor (Doncaster & Micol 1989). Severe winters have been credited extirpating coypu populations in several regions, including

		Scandinavian countries and in areas of the United States with more continental climates (Carter & Leonard 2002; Bertolimo 2009); therefore the northern part of Europe may be not suitable for the species.
19. Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe?	Yes	The species is present in zoological gardens and private collections; but risks for accidental or voluntary releases are limited.
20. Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	yes	Coypu has been introduced and established population in many localities of Europe, North America, Central and Eastern Asia including Japan and Korea, Kenya in East Africa, and the Middle East (Carter & Leonard 2002; Bertolino et al. 2012). Coypus were directly released into the wild to create populations, which may be exploited by trappers (e.g. in North America and Russia), or were maintained for breeding and reproduction in fur farms, from where they frequently escaped or were released (e.g. Europe).
21. Can the organism spread rapidly by natural means or by human assistance?	Yes	The species already spread over large areas in many European countries, as well as in North America and in part of Asia.
22. Could the organism as such, or acting as a vector, cause economic, environmental or social harm in Europe?	Yes	In many areas of introduction, the coypu is considered a pest because of its impact on ecosystems, crops and irrigation systems (Carter & Leonard 2002; Bertolino & Genovesi 2007). The impact of coypu on natural vegetation can be considerable, resulting in the contraction of many aquatic plants; severe restrictions are known on e.g. *Phragmites australis*, *Thypa* spp., *Potamogeton* spp., *Carex* spp., *Nymphaea alba*, *Nuphar lutea* (Wilner et al. 1979; Boorman & Fuller 1981; Bertolino et al. 2005; Prigioni et al. 2005). The overexploitation of reed beds can cause

		large openings in the vegetation (Willner et al. 1979; Boorman & Fuller 1981; Linscombe et al 1981). Coypus may affect waterbird breeding success, as they use bird nests as platform for resting, thus crushing or sinking the eggs during reproduction (Bertolino et al. 2011; Angelici et al. 2011). Coypus are known to eat crop plants, such as cereals, sugarcane, alfalfa, brassicas, ryegrass, saplings of fruit and nut trees, and root crops, especially sugar beet (Schitoskey et al. 1972; Abbas 1991; Gosling & Baker 2008; Panzacchi et al. 2007). The most important economic damage is caused by coypu's burrowing behaviour. Coypus dig extensive burrow systems into the riverbanks and ditches, disrupting drainage systems and posing a risk of flooding in low-lying areas. In Italy, the cost of riverbank repair following damage by coypus, was estimated at nearly 2 million Euros/year (Panzacchi et al. 2007). Extensive burrowing makes dikes and levees susceptible to collapse due to other factors, such as flooding or vehicular traffic (Bounds et al. 2003). The occurrence of *Toxoplasma gondii*, *Chlamydia psittaci*, *Leptospira* spp. was reported in Louisiana (Howerth et al. 1994), leptospirosis in France (Michel et al. 2001) and England (Watkins et al. 1985). Coypus are potentially sources of zoonotic infections and caution should be taken when handling individuals or when in contact with water that might have been contaminated by coypus.

SECTION B – Detailed assessment

PROBABILITY OF ENTRY

Important instructions:

- Entry is the introduction of an organism into Europe. Not to be confused with spread, the movement of an organism within Europe.
- For organisms which are already present in Europe, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.

QUESTION	RESPONSE [chose one entry, delete all others]	CONFIDENCE [chose one entry, delete all others]	COMMENT
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	none	high	The coypu is not traded and is not farmed anymore; therefore, there are no active pathways or potential future pathways. Natural spread from areas where the species is already established poses the most significant risk of expansion.
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).	[insert text]		
Pathway name:	[inset pathway name here]		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)?	intentional accidental	low medium high very high	

(If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)			
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	very unlikely unlikely moderately likely likely very likely	low medium high very high	
1.5. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.	very unlikely unlikely moderately likely likely very likely	low medium high very high	
1.6. How likely is the organism to survive existing management practices during passage along the pathway?	very unlikely unlikely moderately likely likely very likely	low medium high very high	
1.7. How likely is the organism to enter Europe undetected?	very unlikely unlikely moderately likely likely very likely	low medium high very high	
1.8. How likely is the organism to arrive during the months of the year most appropriate for establishment?	very unlikely unlikely moderately likely likely very likely	low medium high very high	
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	very unlikely unlikely moderately likely likely	low medium high very high	

	very likely		
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	very unlikely unlikely moderately likely likely very likely	low medium high very high	
End of pathway assessment, repeat as necessary.			
1.11. Estimate the overall likelihood of entry into GB based on all pathways (comment on the key issues that lead to this conclusion).	very unlikely unlikely moderately likely likely very likely	low medium high very high	

PROBABILITY OF ESTABLISHMENT

Important instructions:

- For organisms which are already well established in GB, only complete questions 1.15 and 1.21 then move onto the spread section. If uncertain, check with the Non-native Species Secretariat.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
1.12. How likely is it that the organism will be able to establish in Europe based on the similarity between climatic conditions in Europe and the organism's current distribution?	very likely	very high	The species is already established in many European countries from Greece to Netherlands; therefore climatic conditions in most of Europe are considered suitable for coypus. Coypu populations are sensitive to climatic conditions and severe winters may be the most limiting factor (Doncaster & Micol 1989). Severe winters have been credited with extirpating coypu populations in several regions including Scandinavian countries and in areas of the United States with more continental climates (Carter & Leonard 2002; Bertolimo 2009); therefore the Northern part of Europe may be not suitable for the species.
1.13. How likely is it that the organism will be able to establish in Europe based on the similarity between other abiotic conditions in Europe and the organism's current distribution?	very likely	very high	The species is found in a variety of aquatic habitats such as wetlands, ponds, lakes, rivers and streams, even in urban areas. These habitats are common throughout Europe. Coypu populations are sensitive to climatic conditions and severe winters may be the most limiting factor (Doncaster & Micol 1989); therefore the northern part of Europe may be not suitable for the species
1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife	likely	high	The species is already keeps in some wildlife parks and zoological gardens.

parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe? Subnote: gardens are not considered protected conditions			
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	widespread	very high	The species is found in a variety of aquatic habitats such as wetlands, ponds, lakes, rivers and streams, even in urban areas. Therefore no single species is "vital" for its survival, development and multiplication. Suitable habitats are present and widely distributed in the Risk Assessment Area.
1.16. If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in Europe?	NA		
1.17. How likely is it that establishment will occur despite competition from existing species in Europe?	very likely	high	The coypu does not suffer competition from other species. Competitive exclusion may occur with the muskrat *Ondatra zibethicus* (also introduced in Europe), but is detrimental to the last species (Bertolino et al. 2012).
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in Europe?	very likely	very high	Caimans in South America and alligators in North America are the most important predators of coypu (Woods et al. 1992). Other predators in the native and introduced ranges are felids and canids, other medium sized carnivores and some birds of prey (Woods et al. 1992; Bounds et al. 2003). This suite of predators, however, has not prevented the establishment, nor the spread of the species in Europe.
1.19. How likely is the organism to establish despite existing management practices in Europe?	likely	high	The coypu has been eradicated from England (Gosling & Baker 1989), and it is controlled by trapping and shooting to reduce damage in several countries (Carter & Leonard 2002; Bertolino & Genovesi 2007). In Italy, during a six-year period (1995-2000),

			despite the removal of 220,688 coypus the species continued to spread (Panzacchi et al. 2007). According to previous experiences, non-intense management operations may impact coypu populations with unexpected effects. The preferential capture of adult males in the first phases of control may create populations dominated by younger classes with a high potential for a subsequent population increase (Gosling & Baker 1989; Reggiani et al. 1993). Individuals escaping from disturbed areas may colonize new areas. Coypu populations were successfully managed also at a large scale, with significant results in terms of coypu population containment (Bertolino et al. 2005; Bertolino & Viterbi 2010) and eradication (Gosling & Baker 1989). An important feature of these projects was an adequate level of trapping effort, which was maintained constant or even increased after first results were achieved (Baker 2006; Bertolino & Viterbi 2010).
1.20. How likely are management practices in Europe to facilitate establishment?	NA		
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	likely	medium	The coypu has been eradicated in 2 small areas in the United States (Carter & Leonard 2002) and from a large area in England (Gosling & Baker 1989). The eradication campaign against the coypus in England is considered one of the most successful eradication projects carried out on mainland and should be used as a reference for future actions (Gosling & Baker 1989; Baker 2006). Key points of the successful campaign were a careful technical planning and a thoughtful evaluation of the human dimension.

			An important feature of successful control projects was an adequate level of trapping effort, which was maintained constant or even increased after first results were achieved (Baker 2006; Bertolino & Viterbi 2010. Non-intense management operations may fails to control or to eradicate the species. The preferential capture of adult males in the first phases of control may create populations dominated by younger classes, with a high potential for a subsequent population increase (Gosling & Baker 1989; Reggiani et al. 1993). Individuals escaping from disturbed areas may colonize new areas.
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?	likely	high	Females are nonseasonal breeders, able to reproduce throughout the year starting when they are less than one year old; the mean litter size is 4-6 young (range 1-12, Weir 1974; Gosling 1981; Bounds et al. 2003; Guichón et al. 2003). Where environmental conditions are not limiting, females can have 2.7 litters/year after a 4 month gestation period with an average of 8-15 young/year (Brown 1975; Willner et al. 1979; Reggiani et al. 1993).
1.23. How likely is the capacity to spread of the organism to facilitate its establishment?	likely	high	The coypu is a semi-aquatic rodent which lives in wetlands, ponds, lakes, rivers and streams. Dispersal occurs mainly along rivers and canals; individuals rarely move more than 100 m away from the banks, whereas they can cover kilometres of a river (Kim 1980; Linscombe et al. 1981; Reggiani et al. 1993). The longest recorded distance travelled along a stream is 3.2. km (Lindscombe et al. 1981), though they have been reported to disperse 120 km downstream in a two-years period (Aliev 1968)
1.24. How likely is the adaptability of the organism to facilitate its establishment?	likely	high	The species could adapt to many aquatic habitats, such as ponds, lakes, rivers and streams; it is also

			found in river and lakes inside urban areas. Coypu populations are sensitive to climatic conditions and severe winters, especially in North Europe, may be the most limiting factor (Doncaster & Micol 1989).
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?	likely	lmedium	There are no data on the effects of propagule pressure and genetic diversity on establishment success. However, the species established and spread in many countries and it is likely that populations would have increased also from few individuals. In many cases, wild populations originated from the releases of animals farmed for their fur. It can therefore be assumed that in several cases the animals were selected for a type of fur, and the genetic variability was reduced
1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in Europe? (If possible, specify the instances in the comments box.)	very likely	very high	Coypu populations are now established in North America, Central and Eastern Asia including Japan and Korea, Kenya in East Africa, and the Middle East (Carter & Leonard 2002; Bertolino et al. 2012). In Europe established populations are present in Austria, Belgium, Bulgaria, Croatia, France, Germany, Greece, Italy, Luxembourg, Netherlands, Romania, Slovakia, Slovenia, Spain (DAISIE website); coypu was also established in England, where it has been eradicated (Gosling & Baker 1989). Therefore it is likely that the species could adapt to other European countries, especially in Central and Southern Europe.
1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in Europe but is established because of continual release, is an example of a transient species.	unlikely	medium	The species has not adapted in northern Europe countries (e.g. Norway and Sweden). If in some areas the species does not establish, then it is probable that the introduced animals will disappear. However, since nowadays main pathway is natural dispersal, new tentative of colonization are likely in many areas.

1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).	very likely	very high	Coypu populations are now established in North America, Central and Eastern Asia including Japan and Korea, Kenya in East Africa, and the Middle East (Carter & Leonard 2002; Bertolino et al. 2012). In Europe established populations are present in Austria, Belgium, Bulgaria, Croatia, France, Germany, Greece, Italy, Luxembourg, Netherlands, Romania, Slovakia, Slovenia, Spain (Bertolino 2009); it was also established in England where it has been eradicated (Gosling & Baker 1989). Therefore it is likely that the species could adapt to other European countries, especially in Central and Southern Europe.

PROBABILITY OF SPREAD

Important notes:

- Spread is defined as the expansion of the geographical distribution of a pest within an area.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
2.1. How important is the expected spread of this organism in Europe by natural means? (Please list and comment on the mechanisms for natural spread.)	major	high	The species established and spread in many countries and this process will continue also in the future till the saturation of suitable areas.
2.2. How important is the expected spread of this organism in Europe by human assistance? (Please list and comment on the mechanisms for human-assisted spread.)	minor	high	Humans were responsible for coypu introductions when animals were released from fur farms or directly introduced in the wild to exploit populations. However, coypu fur market dropped and currently animals are no more farmed. Other human-mediated introduction are not known.
2.3. Within Europe, how difficult would it be to contain the organism?	difficult	high	The species has been eradicated from UK after an intense trapping project. Coypu populations were successfully contained with an adequate level of trapping effort (Bertolino et al. 2005; Bertolino & Viterbi 2010). However, population could quickly recover if control ends. In Italy, despite the removal of 220,688 coypu during years 1995-2000 the species continued to spread. Non-intense management operation, with preferential capture of adult males in the first phases of control, may create populations dominated by younger classes with a high potential for a subsequent population increase (Gosling & Baker 1989; Reggiani et al. 1993).
2.4. Based on the answers to questions on the potential for establishment and spread in Europe, define the area	[insert text]	low medium	Countries were the species is already established (Austria, Belgium, Bulgaria, Croatia, France,

endangered by the organism.		high very high	Germany, Greece, Italy, Luxembourg, Netherlands, Romania, Slovakia, Slovenia, Spain) and neighbour countries are areas endangered by the organism.
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of Europe were the species could establish), if any, has already been colonised by the organism?	10-33	medium	Considering the biogeographic areas suitable for the species (Atlantic, Continental, Mediterranean, Pannonian) and the present distribution (see map in DAISIE website that, however, is updated to year 2008 and therefore underestimate the present range of the species) about 25-30 of the area suitable for establishment has already been colonised by the coypu.
2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0-10	high	The species is spreading in many countries, but considering the extend of the area already occupied, in five year the increase in range would be limited.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Europe? (Please comment on why this timeframe is chosen.)	20	medium	The species is spreading in many countries and in two decades it can be assumed that localized populations in Central and South of Europe could cover large areas.
2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	10-33	medium	The species is spreading in many countries and in two decades it can be assumed that localized populations in Central and South of Europe could cover large areas.
2.9. Estimate the overall potential for future spread for this organism in Europe (using the comment box to indicate any key issues).	moderately	medium	The species could spread along channels, rivers and other wetlands. Therefore, spread rate is influenced by the hydrography

PROBABILITY OF IMPACT

Important instructions:

- When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment.
- Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section).
- Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in Europe separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.

QUESTION	RESPONSE	CONFIDENCE	COMMENTS
2.10. How great is the economic loss caused by the organism within its existing geographic range excluding Europe, including the cost of any current management?	massive	medium	In Italy, during a six-year period (1995-2000) with a management cost of € 2,614,408, the damage produced by the species amounted to € 11,631,721 (Panzacchi et al. 2007). Kettunen et al. (2009) considering the whole current European range extrapolated a cost of 65.69 million €/year. Economic loss are associated to damage to agriculture, river banks and control costs. The most important economic damage is caused by coypu's burrowing behaviour. Coypus dig extensive burrow systems into the riverbanks and ditches. In Italy, the cost of riverbank repair following damage by coypus, was estimated at nearly 2 million Euros/year (Panzacchi et al. 2007).
2.11. How great is the economic cost of the organism currently in Europe excluding management costs (include any past costs in your response)?	massive	medium	In Italy, during a six-year period (1995-2000) the damage produced by the species amounted to € 11,631,721 (Panzacchi et al. 2007). Kettunen et al. (2009) considering the whole current European range extrapolated a cost of 65.69 million €/year without a distinction between damage and management costs.

2.12. How great is the economic cost of the organism likely to be in the future in Europe excluding management costs?	massive	medium	Economic cost of coypu would likely increase with the spread of the species.
2.13. How great are the economic costs associated with managing this organism currently in Europe (include any past costs in your response)?	major	medium	In Italy, during a six-year period (1995-2000) management costs were € 2,614,408. Kettunen et al. (2009) considering the whole current European range extrapolated a cost of 65.69 million €/year without a distinction between damage and management costs.
2.14. How great are the economic costs associated with managing this organism likely to be in the future in Europe?	major	medium	Management costs would likely increase with the spread of the species
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding Europe?	major	high	Coypus are generalist herbivores which can feed on a wide variety of plant materials, including leaves, stems and roots. As a result of this feeding activity, large areas of *Nuphar lutea*, *Rumex* spp., *Sagittaria* spp., *Scirpus* spp., *Phragmites australis*, *Trapa natans*, *Typha* spp., may be eliminated (Ellis 1963; Willner et al. 1979; Boorman & Fuller 1981; Bertolino et al. 2005). Coypus could exert impacts on waterbirds, by using their nests as platform for resting and, therefore, crushing or sinking the eggs (Bertolino et al. 2011; Angelici et al. 2012). In USA where the species has also been introduced, coypu has an important impact on the aboveground biomass of native marsh plant species, such as chairmaker's bulrush, *Scirpus americanus* (Johnson & Foote 1997) and arrowheads, *Sagittaria latifolia* and *S. platyphylla* (Llewellyn & Shaffer 1993). In Louisiana and Maryland coypu feeding activity has been associated with the loss of brackish and freshwater marshes through a process known as eatout (Foote & Johnson 1993; Carter et al. 1999).

2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) currently in Europe (include any past impact in your response)?	major	high	The species could locally reduce the aquatic vegetation for its feeding activity and impact some waterbird species, by crushing or sinking their eggs. However, the impact on single species over large areas is not clear.
2.17. How important is the impact of the organism on biodiversity likely to be in the future in Europe?	major	high	Present impact will increase in the future due to the spread of the species.
2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism currently in Europe (include any past impact in your response)?	major	high	The main impact is habitat destruction and changes in the composition of local plant communities. Its preferential feeding on rhizomes or reeds reduces vegetal biodiversity and plant cover, leading to changes in the flow speed of the river, erosion and flood (Barrat et al. 2010). In the Norfolk Broads (UK), selective feeding on *Phragmites australis* opened up the waterways and changed the vegetation composition (Boorman & Fuller 1981).
2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism likely to be in Europe in the future?	major	high	The spread of the species in many countries would increase the surface where coypu could affect ecosystem functions.
2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism currently in Europe?	major	medium	Changes in the composition of local plant communities, and in the flow speed of rivers (Boorman & Fuller 1981; Barrat et al. 2010) will likely decrease the conservation status of wetlands where coypus are present. For instance, studies showed an impact to EU 92/43 "Habitat" Directive Habitat: 3150 Natural eutrophic lakes, 3160 Natural dystrophic lakes and ponds (Bertolino et al. 2005); 1130 Estuaries, 1150 Coastal lagoons 1410 with reedbeds and other species (Boorman & Fuller 1981): Mediterranean salt meadows (Marini et al. 2011, 2013).
2.21. How important is decline in conservation status (e.g.	major	medium	The spread of the species in many countries would

sites of nature conservation value, WFD classification) caused by the organism likely to be in the future in Europe?			increase the surface where coypu could decrease the conservation status of habitats listed in the EU 92/43 "Habitat" Directive Habitat.
2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious?	minimal	high	
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	major	high	Coypus are implicated in leptospirosis (e.g. Waitkins et al. 1985; Michel et al. 2001; Bollo et al. 2003). Vein et al. (2013 online first) found a significant prevalence of kidney carriage (8.0 - 12.1%) and consider coypu as a real reservoir for leptospirosis. Human leptospirosis is considered an emerging risk for Europe (Dupouey 2014). Nardoni et al. (2011) found coypu heavily parasitized with *Toxoplasma*, suggesting that the species could be a reservoir of this parasite
2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	major	high	Coypus are implicated in leptospirosis (e.g. Waitkins et al. 1985; Michel et al. 2001; Bollo et al. 2003). Vein et al. (2013 online first) found a significant prevalence of kidney carriage (8.0 - 12.1%) and consider coypu as a real reservoir for leptospirosis. Human leptospirosis is considered an emerging risk for Europe (Dupouey 2014). Nardoni et al. (2011) found coypu heavily parasitized with *Toxoplasma*, suggesting that the species could be a reservoir of this parasite
2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment box)	major	high	Coypus dig extensive burrow systems into the riverbanks and ditches, disrupting drainage systems and posing a risk of flooding in low-lying areas. In Italy, the cost of riverbank repair following damage by coypus, was estimated at nearly 2 million Euros/year (Panzacchi et al. 2007). Extensive burrowing makes dikes and

			levees susceptible to collapse due to other factors, such as flooding or vehicular traffic (Bounds et al. 2003).
2.26. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Europe?	major	high	Possible predators in Europe are felids and canids, other medium sized carnivores and some birds of prey (Bertolino et al. 2012); their predation is however limited and may not impact populations.
2.27. Indicate any parts of Europe where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	[insert text + attach map if possible]	high	Most of the countries where the species is already established: Austria, Belgium, Bulgaria, Croatia, France, Germany, Greece, Italy, Luxembourg, Netherlands, Romania, Slovakia, Slovenia, Spain (Map in DAISIE website).

RISK SUMMARIES

	RESPONSE	CONFIDENCE	COMMENT
Summarise Entry	very likely	very high	The coypu is not traded and is not farmed anymore; therefore there are no active pathways or potential future pathways. Natural spread from areas where the species is already established poses the most significant risk of expansion.
Summarise Establishment	very likely	very high	The species is already established in many European countries: Austria, Belgium, Bulgaria, Croatia, France, Germany, Greece, Italy, Luxembourg, Netherlands, Romania, Slovakia, Slovenia, Spain. Management actions aimed at limiting damage and/or populations are ongoing in some countries, but results are not always known and their effectiveness is sometime questionable.
Summarise Spread	moderately	medium	The species established and spread in many countries and this process will continue also in the future till the saturation of suitable areas. Climatic conditions in most of Europe are considered suitable for grey squirrels, except for the Northern countries (e.g. Scandinavia and Baltic countries).
Summarise Impact	massive	high	The main ecological impact is habitat destruction and changes in the composition of local plant communities. Coypus are generalist herbivores that can feed on a wide variety of plant materials, including leaves, stems and roots. As a result of this feeding activity, large areas of aquatic vegetation may be eliminated (Ellis, 1963; Willner et al. 1979; Boorman & Fuller 1981; Bertolino et al. 2005). Its preferential feeding on

			rhizomes or reeds reduces vegetal biodiversity and plant cover, leading to changes in the flow speed of the river, erosion and flood (Barrat et al. 2010). Coypus could impact waterbirds using their nests as platform for resting and, therefore, crushing or sinking their eggs (Bertolino et al. 2011; Angelici et al. 2012). Economic loss are associated to damage to agriculture, river banks and control costs. The most important economic damage is caused by coypu's burrowing behaviour. Coypus dig extensive burrow systems into the riverbanks and ditches, disrupting drainage systems. Extensive burrowing makes dikes and levees susceptible to collapse due to other factors, such as flooding or vehicular traffic (Bounds et al. 2003). Cost of coypu management (damage and species control) in Italy, amounted to € 11,631,721 in six years (Panzacchi et al. 2007). Kettunen et al. (2009) considering the whole current European range extrapolated a cost of 65.69 million €/year. Coypu are implicated in leptospirosis (e.g. Waitkins et al. 1985; Michel et al. 2001; Bollo et al. 2003). Vein et al. (2013 online first) found a significant prevalence of kidney carriage (8.0 - 12.1%) and consider coypu as a real reservoir for leptospirosis. Human leptospirosis is considered an emerging risk for Europe (Dupouey 2014).
Conclusion of the risk assessment	high	high	The species is already established in many countries and it is spreading in Europe. A large number of scientific publications demonstrate the invasiveness of the species in aquatic ecosystems and its economic impact due to damage to crops and river banks.

Additional questions are on the following page ...

ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	[insert text]	high	Coypu populations are sensitive to climatic conditions and severe winters may be the most limiting factor (Goslin 1981; Doncaster & Micol 1989). Therefore, the present climate change may further benefit the species in colonising new areas.
3.2. What is the likely timeframe for such changes?	50 - 100 years	medium	
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	[Increase climatic suitability of Northern areas]	medium	
ADDITIONAL QUESTIONS - RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	[The species invasiveness is demonstrated by many papers]	high	Confidence in the risk assessment is high. The species is established in many European countries and a large number of scientific publications demonstrate the invasiveness of coypu, its ecological and economic impact. The species is also established in other continents (e.g. North America and Asia) and scientific publications from North America demonstrate a similar impact, if not even higher. Further research should better quantify economic cost over large areas and effectiveness of control programs in term of population containment and ecological or economic damage reduction.

Please provide a reference list on the following page ...

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EUROPE NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: ***Sciurus carolinensis***
Author: Sandro Bertolino, Adriano Martinoli, Lucas Wauters; reviewed by John Gurnell and Peter Lurz (Great Britain)
Risk Assessment Area: European Union (28 Countries)

Draft: Draft 1 (*30/06/2014*)

EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	Great Britain, Ireland, Italy
2. In how many EU member states has this species currently established populations? List them.	Great Britain, Ireland, Italy
3. In how many EU member states has this species shown signs of invasiveness? List them.	Great Britain, Ireland, Italy
4. In which EU Biogeographic areas could this species establish?	The suitability was evaluated with a comparison of the biogeographical regions with the European projections of the grey squirrel's climatic niche (Di Febbraro et al. 2013, see map below). High climatic suitability (0.6-1.0): Atlantic, Black Sea, Continental (Western Part), Macaronesia (Azores), Mediterranean (excluding part of Spain) Medium climatic suitability (0.4-0.6): Alpine (Eastern Alps), Continental (Eastern Part), Pannonian, Macaronesia (Canary Islands) Low climatic suitability (<0.4): Alpine (Western Alps), Anatolian, Arctic, Boreal
5. In how many EU Member States could this species establish in the future [given current climate] (including those where it is already established)? List them.	Based on simulation of the grey squirrel's climatic niche in Maxent suitability is: High (suitability > 0.6) in United Kingdom, Ireland, Portugal, Spain, France, Italy, Netherlands, Belgium, Luxembourg, Germany, Austria, Czech Republic, Slovenia, Croatia, Denmark, Bulgaria, Hungary, Romania, Greece, Cyprus. Lower (suitability < 0.6) in Sweden, Finland, Lithuania, Latvia, Estonia, Slovakia, Poland, Malta,
6. In how many EU member states could this species become invasive in the future [given current climate] (where it is not already established)?	The species could become invasive in most of Europe, if established (see question 5), mainly for the possibility to replace the native red squirrel that is the only native tree squirrel present in Europe. The confidence of this prediction is higher in parts of Europe where mixed broadleaves forests are dominant and lower for areas where conifers are dominant.

SECTION A – Organism Information and Screening		
Stage 1. Organism Information	**RESPONSE** **[chose one entry, delete all others]**	**COMMENT**
1. Identify the organism. Is it clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	*Sciurus carolinensis* Gmelin, 1788. EN: grey squirrel; FR: Écureuil gris; IT: Scoiattolo grigio; D: Grauhörnchen	Yes, this species can be adequately distinguished from other entities of the same genus.
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	NA	
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	No	No risk assessment has been carried out for the whole of Europe. A Risk Assessment has been conducted in Belgium and the result was that the species has high potential of establishment and dispersal in that country. For these reasons the species was included in the Black list (Score 11) and in the Alert list (AO) for its potential high environmental hazard. In Italy, the Grey squirrel Pest Risk Assessment has been produced following three different European procedures. With the Belgian system (Invasive Species Environmental Impact Assessment) the final list score was: A2 (black list). Using the Quickscan Risk Assessment method, according to a report for the Commission for Invasive exotic species (COIE) of the Netherlands Ministery of Agriculture, Nature and Food quality, the final evaluation was that this organism could present a risk to the Risk Assessment area (Italy). With the UK non-native organism risk assessment scheme version 3.3 the final evaluation was: risk of entry: 4 (very likely),

		risk of establishment: 4 (very likely), risk of spread: 2 (intermediate), impacts 3 (major).
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	No	They only consider single countries.
5. Where is the organism native?		North America
6. What is the global distribution of the organism (excluding Europe)?		The species is native to North America where it is distributed from the Gulf of Mexico, the Eastern United States to the southern part of Quebec and Ontario (Koprowski 1994). Grey squirrels have been introduced to many localities of North America (USA and Canada), Australia (2 areas extinct, 1 area eradicated), and South Africa (Long 2003; Wood et al. 2007; Bertolino 2009; Peacock 2009).
7. What is the distribution of the organism in Europe?		Expanding grey squirrel populations are present in Great Britain, Ireland and Italy (O'Teangana et al. 2000; Gurnell et al. 2008b; Martinoli et al. 2010)
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes	Grey squirrels have been introduced and established population in many localities of North America (USA and Canada), South Africa (Long 2003; Bertolino 2009) and Europe (UK, Ireland, Italy). Already reported in the IUCN list of 100 worst invasive species (Lowe et al. 2000). The grey squirrel is impacting biodiversity and commercial forestry in Great Britain through bark stripping (Kenward & Parish 1986; Kenward et al. 1992; Mayle et al. 2003; Gurnell et al. 2008). Bark stripping increases the risk of fungal infections and invertebrate damage, which can reduce timber yield (Mayle 2010). Tree species, age and time of year influence the risk of squirrel damage (Mayle et al. 2008). Beech (*Fagus sylvatica*) and sycamore

		(*Acer pseudoplatanus*) are at the greatest risk of damage but any thin-barked tree species between 10 and 40 years old is at risk e.g. oak (*Quercus* spp.), sweet chestnut (*Castanea sativa*), larch (*Larix* spp.) and Norway spruce (*Picea abies*) (Mayle, 2004; Mayle & Broome 2013). Bark stripping has influenced woodland management practices in England, where a shift away from trees susceptible to squirrel damage has been observed (Mayle, 2005), with an influence on the flora and fauna associated with specific woodland types. Grey squirrels predate eggs and fledgling of birds; at present there is little evidence of any national population declines in woodland bird species as a result of this predation, but further research is needed to exclude impacts for specific species and habitats (Amar et al., 2006; Newson et al., 2010).
9. Describe any known socio-economic benefits of the organism in the risk assessment area.	None known	
Stage 2. Screening Questions		
10. Has this risk assessment been requested by the a Programme Board? (If uncertain check with the Non-native Species Secretariat)	NA	
11. What is the reason for performing the risk assessment?	Identification of invasive alien species of EU concern	
12. Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		Tree squirrels are highly adaptive and opportunistic species and viable populations could establish from few founders. The likelihood ratio for a couple of *Sciurus* spp. (*S. aberti*, *S. aureogaster*, *S. carolinensis*, *S. niger* the introduced species considered) to successfully

		establish a viable population is 57% and a likelihood ratio of 90% is achieved with >14 animals (Bertolino 2009). Females can have 2 litters/year with 2-5 weaned young; varying percentage of adult females reproduce in a given season, depending on food quality and quantity. Dispersal capacity is high, juveniles can move easily between 1 and 3 (5) km from the natal site (Koprowski 1994; Wauters et al. 1997; Lurz et al. 2001). The species lives in deciduous, mixed and coniferous woodland habitats feeding on tree seeds and a variety of other foods (tree flowers, buds, mushrooms, berries, occasionally insects and bird eggs/young; they may sometimes feed on cereals (e.g. maize). The species is commonly found in suburban areas where it benefits from supplemental feeding (Bonnington et al.2013, 2014).
13. Does the organism occur outside effective containment in Europe?	Yes	
14. Is the organism widely distributed in Europe?	Yes	Grey squirrel populations are present in Great Britain (see map in Gurnell et al. 2008b), Ireland (O'Teangana et al. 2000) and Italy (Martinoli et al. 2010)
15. Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in Europe, in the open, in protected conditions or both?	Yes	The species is found in deciduous and mixed forest, farmland with small scattered woodland cover and in urban parks (open); it is also present in zoological gardens and as a pet in private houses and parks (protected conditions).
16. Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg	No	

incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?		
17. Is the other critical species identified in question 15 (or a similar species that may provide a similar function) present in Europe or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed.	NA	
18. Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of Europe or sufficiently similar for the organism to survive and thrive?	Yes	Climatic conditions in most of Europe are considered suitable for grey squirrels (Di Febbraro et al. 2013). The species is found in eco-temperate climatic zones (Gurnell 1987; Bertolino 2008); in the natural range from north to south, there are very large changes in weather (Koprowski 1994) indicating adaptability to different climatic condition. The adaptability of the species is also confirmed by a shift in its climatic niche in Europe (Di Febbraro et al. 2013).
19. Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe?	Yes	The species is present in zoological gardens and private collections; therefore, there are risks for accidental or voluntary releases.
20. Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	Yes	The species has been introduced to many localities of North America, Australia (extinct or eradicated), South Africa, Great Britain, Ireland and Italy (Long 2003; Bertolino2009). In Europe, the grey squirrel was introduced to Great Britain on more than 30 occasions from 1876 until 1929 (Middleton1932; Shorten 1954; Gurnell 1987) and to Ireland in 1913 (O'Teangana et al. 2000). At least 20 separate introductions took place in Italy (Bertolino 2009; Martinoli et al.2010). Presently, the range of introduced grey squirrel populations

		covers most of England and Wales, part of Scotland, the eastern part of Ireland, as well as many areas in Northwestern Italy and a location in central Italy (Wauters et al.1997; O'Teangana et al. 2000; Bertolino 2008; Gurnell et al. 2008b; Martinoli et al. 2010)
21. Can the organism spread rapidly by natural means or by human assistance?	Yes	High natural dispersal capacity (Koprowski 1994; Wauters et al. 1997; Lurz et al. 2001; Bertolino et al. 2008). Humans can further promote the spread of the species with translocation from one area to another (Shorten 1954; Martinoli et al. 2010; Signorile et al. 2014a,b)
22. Could the organism as such, or acting as a vector, cause economic, environmental or social harm in Europe?	Yes	The grey squirrel is replacing the native red squirrel (*Sciurus vulgaris*) in Great Britain (Gurnell & Pepper 1993; Gurnell et al. 2008a,b), Ireland (O'Teangana et al. 2000) and Italy (Martinoli et al. 2010; Bertolino et al. 2014), through resource competion (Wauters et al. 2002a,b; Gurnell et al. 2004); in Great Britain and Ireland the replacement is also disease-mediated, as the species act as a reservoir host to a squirrel poxvirus that causes high mortality in red squirrels (Sainsbury et al. 2000; Tompkins et al. 2002; Rushton et al. 2006). The species is impacting biodiversity and commercial forestry in Great Britain through bark stripping (Mayle et al. 2003; Gurnell et al. 2008; Mayle & Broome 2013). Bark stripping has influenced woodland management practices in England, where a shift away from trees susceptible to squirrel damage has been observed (Mayle, 2005) with an influence on the flora and fauna associated with specific woodland types. Squirrels predate eggs and fledgling of birds; further studies are required on whether they contribute to the

		decline of particular woodland bird species (Amar et al., 2006; Newson et al., 2010). Economic impact of bark stripping damage in Great Britain. Total costs for grey squirrel management in UK forests (damage + control) is estimated at GBP 6,097,320 (Williams et al. 2010) - GBP 10 million (Anon. 2006; Mayle & Broome 2013) annually. Damage done by grey squirrels to property (damage to furniture, ornaments, cables) is estimated to be GBP 5,128,274; while the cost of removing squirrels in buildings and other infrastructure is estimated in GBP 1,914,555 (total damage + control GBP 7,042,829) (Williams et al. 2010). Projected annual costs for grey squirrel management in Irish (Ireland and Northern Ireland) forests is € 856,141; the cost to the agricultural sectors is € 4,580,818 and for building protection is € 988,978 (Kelly et al. 2013). In Italy limited damage to maize crops and poplar plantations are recorded (Currado 1993; Currado et al. 1997; Signorile and Evans 2007), but costs are not estimated. The species is also reported to be a garden pest by digging up bulbs and eating fruits and the bark of ornamental plants, and can damage properties, chewing timber, wires and stored goods. Social conflict expected on eradication programmes that will be inacceptable for extreme animal-rights groups (Bertolino et al. 2003; Anon. 2013); however, on this aspect see the position paper of the Eurogroup for Animals (July 2013, EU Strategy on Invasive Alien Species), a leading voice for animal welfare at European Union level, which recognise that in some cases it may be more humane and have less negative impact on animal

		welfare to utilise a rapid lethal method than longer term controls impacting larger number of animals.

SECTION B – Detailed assessment

PROBABILITY OF ENTRY

Important instructions:

- Entry is the introduction of an organism into Europe. Not to be confused with spread, the movement of an organism within Europe.
- For organisms which are already present in Europe, only complete the entry section for current active pathways of entry or if relevant potential future pathways. The entry section need not be completed for organisms which have entered in the past and have no current pathways of entry.

QUESTION	RESPONSE [chose one entry, delete all others]	CONFIDENCE [chose one entry, delete all others]	COMMENT
1.1. How many active pathways are relevant to the potential entry of this organism? (If there are no active pathways or potential future pathways respond N/A and move to the Establishment section)	few	very high	The species is already present in the Risk Assessment area with viable and spreading populations in three countries. The pathway for new introduction is escapes from pet owners, deliberate release from pet owners, deliberate introductions.
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific origins and end points of the pathways. For each pathway answer questions 1.3 to 1.10 (copy and paste additional rows at the end of this section as necessary).	[Pet-trade]		The primary pathway for entry involves their escape or deliberate release from captivity (see as an example of squirrel's pathway the video on YouTube regarding an illegal release of a chipmunk, *Tamias* sp. (http://www.youtube.com/watch?v=p_Ee4Bvk-eU). The origin of the pathway is considered to be the keeping of the animals in captivity but also deliberate introductions in parks and woods. Likelihood of association is considered to remain high as long as the species continues to be kept in captivity and sold by pet shops (Bertolino 2009). Natural populations could be the source of animals for an illegal trade of the species (Signorile et al. 2014b).

Pathway name:	[Pet-Trade]		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)	intentional	very high	The species is intentionally imported and traded in many European countries (UNEP-WCMC 2010). The animals may then be released or escape.
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.	moderately likely	medium	Trade statistics are not available. An internet survey conducted in May 2010, in order to investigate whether the species appears to be traded within the EU, and whether there appears to be demand for this species as a pet, found adverts for the sale of grey squirrels on Austrian, Danish, French, Great Britain, Italian, and Spanish websites; there were several advertisements for people wanting 'squirrels' in French, British, Italian, and Spanish websites (UNEP-WCMC 2010).
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	very likely	high	Natural populations can establish from few founders and grow quickly (Shorten 1954; Bertolino 2009; Wood et al. 2007;Signorile et al. 2014a). The species is often released in urban parks, suburban gardens, parkland, etc., which could provide suitable habitats with supplemental feeding from humans (Bonnington etb al. 2013, 2014), and from here spread to forested habitats (deciduous, mixed and coniferous woodland) (Bertolino et al. 2014).
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	likely	high	The species is already present in three countries and is traded in many others.
End of pathway assessment, repeat as necessary.			
1.11. Estimate the overall likelihood of entry into Europe based on all pathways (comment on the key issues that lead to this conclusion).	likely	high	The principal pathway for entry is escape or release from captivity. The origin of the pathway is considered to be the keeping of the animals in captivity but also

			deliberate introductions in parks and woods. Likelihood of association is considered to remain high as long as the species continues to be kept in captivity and sold by pet shops (Bertolino 2009). Natural populations could be the source of animals for an illegal trade of the species (Signorile et al. 2014b). The importation of the grey squirrel was suspended in the European Union in year 2012 by including it in a list of species whose introduction in Europe is suspended on the basis of the evidence that they constitute an ecological threat to biodiversity. This list is an implementation of the CITES regulation and is directly applicable in all Member States. This, however, does not stop the movements of animals within Europe where the species is already bred and sold in many countries (UNEP-WCMC 2010). In Italy the limitation is now even more stringent. A Decree signed on 24th December 2013 by the Ministers of the Environment, Agriculture and Economic Development and published on 2nd February 2014 forbids trading, raising and keeping of grey squirrels and two other squirrel species (*Sciurus niger*, *Callosciurus erythraeus*). In UK, under the Wildlife and Countryside Act (1981) it is illegal to release non-indigenous animals into the wild, so any grey squirrels caught should be killed.

PROBABILITY OF ESTABLISHMENT

Important instructions:

- For organisms which are already well established in Europe, only complete questions 1.15 and 1.21 then move onto the spread section. If uncertain, check with the Non-native Species Secretariat. For Europe mainland, grey squirrel is established only in Italy, while other populations are on islands (Great Britain, Ireland); therefore all questions were completed

QUESTION	RESPONSE	CONFIDENCE	COMMENT
1.12. How likely is it that the organism will be able to establish in Europe based on the similarity between climatic conditions in Europe and the organism's current distribution?	very likely	very high	The species already established in Great Britain, Ireland and Italy (Bertolino 2009); only Italy is part of mainland Europe. According to statistical prediction models that simulate the possible expansion of the grey squirrel from Italy, in the medium term the grey squirrel will be able to colonize the Alps, the Apennines and the bordering countries of France and Switzerland in next decades (Lurz et al. 2001; Tattoni et al. 2006; Bertolino et al. 2008). These studies support the presence of suitable habitats in these areas. A recent study also supports the hypothesis of a shift in the grey squirrel's climatic niche in the area of introductions. Climatic conditions in most of Europe were considered suitable for grey squirrels (Di Febbraro et al. 2013).
1.13. How likely is it that the organism will be able to establish in Europe based on the similarity between other abiotic conditions in Europe and the organism's current distribution?	very likely	very high	Temperate forests and woodlands in Europe have many tree species that are similar (same genus) than in the native area of grey squirrels and thus produce food resources similar in quantity and quality; (sub)urban park populations occur both in Europe and N. America. Climatic conditions in most of Europe are considered suitable for grey squirrels (Di Febbraro et al. 2013).

1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe? Subnote: gardens are not considered protected conditions	very likely	very high	The species is already keeps in wildlife parks, zoological gardens, private collections and pet shops.
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	widespread	very high	The species lives in deciduous, mixed and coniferous woodland habitats, feeding on nuts, seeds, tree flowers, buds, mushrooms, berries, caterpillars, rarely on insects and bird eggs/young and sometimes on cereals (maize). The species is also regularly found in parks and towns. Therefore no single species is "vital" for its survival, development and multiplication. Suitable habitats are present and widely distributed in the Risk Assessment Area.
1.16. If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in GB?	NA		
1.17. How likely is it that establishment will occur despite competition from existing species in Europe?	very likely	very high	Outcome of competition with the only native tree squirrel species (red squirrel, *Sciurus vulgaris*) is in favour of the alien species (Gurnell & Pepper 1993; Kenward & Holm 1993; Wauters et al. 2001, 2002a, b; Gurnell et al. 2004)
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in Europe?	very likely	high	A range of potential predators exist in Europe, these include raptors, red fox (*Vulpes vulpes*), stone and pine marten (*Martes* spp.), feral and domestic cats, and potentially owls. This suite of predators has not prevented the establishment, nor the spread of the animals. Feral/domestic cats may have an impact in some urban areas (Bertolino & Genovesi 2005). Pine marten (*Martes martes*)

			seems to have an impact in some parts of Ireland (Sheehy et al. 2014).
1.19. How likely is the organism to establish despite existing management practices in Europe?	likely	high	A national bounty scheme in the Great Britain between 1953 and 1958 did not reduce numbers or geographic range of the grey squirrel, or damage to trees, and was stopped (Shorten 1957; Thompson & Peace 1962; Sheail 1999). Subsequent control actions in Great Britain, Ireland and Italy show that high removal rates are necessary to obtain success and that numbers return quickly to pre-control levels once killing is stopped (Lawton & Rochford 2007). The management of the grey squirrel in Italy aims to stop the spread of the species to other countries. Though successful, these management actions would stop the spread of established populations, but not the risk for Europe. The main pathway of entry is the pet trade and the risk of new introductions in other European countries continues to be present.
1.20. How likely are management practices in Europe to facilitate establishment?	NA		
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	likely	medium	So far no eradication campaigns have been started, but control actions in the Great Britain, Ireland and Italy show that high removal rates are necessary to obtain success and that numbers return quickly to pre-control levels once killing is stopped (Lawton & Rochford 2007). Once established, grey squirrels are difficult if not impossible (with large populations) to eradicate though some success can be achieved at a local level with a high control effort (Schuchert et al. 2014)
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?	very likely	very high	Can have 2 litters/year with 2-5 weaned young; varying percentage of adult females reproduce in a

			given season (Gurnell 1987; Koprowki 1994). The animals are attractive to humans that feed populations in urban parks or nearby. This could help small populations to overcome the first phase when extinction is possible.
1.23. How likely is the capacity to spread of the organism to facilitate its establishment?	very likely	very high	Dispersal capacity high, juveniles can move easily between 1 and 3 (5) km from the natal site (Koprowski 1994; Wauters et al. 1997; Lurz et al. 2001)
1.24. How likely is the adaptability of the organism to facilitate its establishment?	very likely	very high	The species could adapt to urban, suburban and more natural area, occurring in a variety of woodland habitat types
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?	very likely	very high	Grey squirrels have proven to be very successful invaders able to start new populations and spread even from few founders with low genetic diversity (Wood et al., 2007; Bertolino 2009; Signorile et al. 2014 a,b).
1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in Europe? (If possible, specify the instances in the comments box.)	very likely	very high	59 out of 74 (79.7%) introductions outside the native range in US, Canada, Europe, Australia, South Africa, were successful (Bertolino 2009). The species already established in North (Great Britain and Ireland) and South (Italy) Europe, showing its ability to adapt to European habitats
1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in GB but is established because of continual release, is an example of a transient species.	unlikely	medium	If the species does not establish, as in an urban park in Rome in the 1980s (Bertolino & Genovesi 2005), and in some areas in Great Britain (Shorten 1954) and in Australia (Long 2003), then it is probable that the introduced animals will disappear. However, the risk of new introductions will continue to remain.
1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).	likely	high	The species already established in North (Great Britain and Ireland) and South (Italy) Europe. Climatic conditions in most of Europe are considered suitable for grey squirrels (Di Febbraro

			et al. 2013). The species is found in eco-temperate climatic zones (Bertolino 2008, 2009); in the natural range from north to south (Koprowski 1994), there are very large changes in weather to indicate a certain adaptability of the species. The species could adapt to urban, suburban and more natural area, occurring in a variety of woodland habitat types. Grey squirrels have proven to be very successful invaders able to start new populations world-wide even from few founders with low genetic diversity (Wood et al., 2007; Bertolino 2009; Signorile et al. 2014 a,b). Humans could help the spreading feeding the animals or translocating them to new areas. It must be underlined that both Ireland and Great Britain are islands and the main risk to the rest of Europe comes from pet trade and range expansion form Italy. Grey squirrels in Italy should therefore be a priority in terms of action.

PROBABILITY OF SPREAD

Important notes:

- Spread is defined as the expansion of the geographical distribution of a pest within an area.

QUESTION	RESPONSE	CONFIDENCE	COMMENT
2.1. How important is the expected spread of this organism in Europe by natural means? (Please list and comment on the mechanisms for natural spread.)	high	high	Active saturation dispersal, mainly of immature individuals, which will colonize new areas of suitable habitat. Information on the spread of the species are reported by Okubo et al. (1989) for England, by O'Teangana et al. (2000) for Ireland and Bertolino et al. (2014) for Italy.
2.2. How important is the expected spread of this organism in Europe by human assistance? (Please list and comment on the mechanisms for human-assisted spread.)	major	high	Squirrels are often released in or near urban areas such as parks, where they could benefit from supplementary feeding by humans. This could increase survival and help to overcome first periods with very low density. All 32 introductions in UK and Ireland were human mediated; at least 11 were translocations from other populations already established. (Shorten 1954). The same probably happened in north Italy (Martinoli et al. 2010) and was documented for central Italy (Signorile et al. 2014b).
2.3. Within Europe, how difficult would it be to contain the organism?	difficult	medium	Likelihood is that it could be 'contained' where it doesn't spread over large areas, partly because of seasonally high trappability, and partly because of easy recognition of the species in new areas. However, practical difficulties likely to arise because of diverse landownership patterns likely to be encountered in typical release/escape areas and because of potential public opposition to

			control/eradication (Barr et al. 2002; Rushton et al. 2002; Anon. 2013).
2.4. Based on the answers to questions on the potential for establishment and spread in Europe, define the area endangered by the organism.	[Most of Europe]	high	See bioclimatic model for the species in Di Febbraro et al. (2013) and questions 4 and 5 of EU CHAPPEAU
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of Europe were the species could establish), if any, has already been colonised by the organism?	10-33	high	See distribution maps in Bertolino (2008) and bioclimatic model for the species in Di Febbraro et al. (2013).
2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded by the organism five years from now (including any current presence)?	0-10	high	Expansion of the colonies in North and Central Italy, Ireland and Scotland.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Europe? (Please comment on why this timeframe is chosen.)	10	medium	In 2010 Italian authorities started a LIFE funded project (LIFE09 NAT/IT/00095 EC-SQUARE), with the aim to control the grey squirrel across different regions on Northern Italy. A second LIFE project (LIFE13 BIO/IT/000204 U-SAVEREDS) is due to start in October 2014 with the aim to eradicate the grey squirrel from central Italy (Umbria). These LIFE projects will end in 2015 and 2018 and in this timeframe information on the possibility to eradicate or control the species in Italy will become available.
2.8. In this timeframe what proportion (%) of the endangered area/habitat (including any currently occupied areas/habitats) is likely to have been invaded by this organism?	0-10	medium	If control actions fails, the species would invade further areas in north and central Italy in this timeframe.
2.9. Estimate the overall potential for future spread for this organism in Europe (using the comment box to indicate any key issues).	rapidly	medium	Based on the results of a spatially explicit population dynamic model it is believed that in 20-40 years from 1996 the species can colonize the western Alps in the provinces of Cuneo and Turin and in about 30 years

			reach France (i.e. by 2026). The populations in Lombardy would take 20-40 years to colonize the area along the Ticino river and Lake Maggiore and the first grey squirrels could easily reach Switzerland in the decade 2030-2040 (Lurz et al. 2001; Tattoni et al. 2006; Bertolino et al. 2008). These prediction, however, are based on modeling the spread of only three populations (Bertolino et al. 2008), while now there more than 20 populations are known for Italy (Martinoli et al. 2010) and do not assume further jumps via human-mediated translocations. In case of new introduction in other countries, the likelihood of establishment is high and the spread could be from moderate to rapid, depending on the habitat.

PROBABILITY OF IMPACT

Important instructions:

- When assessing potential future impacts, climate change should not be taken into account. This is done in later questions at the end of the assessment.
- Where one type of impact may affect another (e.g. disease may also cause economic impact) the assessor should try to separate the effects (e.g. in this case note the economic impact of disease in the response and comments of the disease question, but do not include them in the economic section).
- Note questions 2.10-2.14 relate to economic impact and 2.15-2.21 to environmental impact. Each set of questions starts with the impact elsewhere in the world, then considers impacts in GB separating known impacts to date (i.e. past and current impacts) from potential future impacts. Key words are in bold for emphasis.

QUESTION	RESPONSE	CONFIDENCE	COMMENTS
2.10. How great is the economic loss caused by the organism within its existing geographic range, including the cost of any current management?	major	high	Total costs for grey squirrel management in UK forests (damage + control) is estimated at GBP 6,097,320 (Williams et al. 2010) - GBP 10 million (Anon. 2006; Mayle & Broome 2013) annually. Damage done by grey squirrels in properties (damage to furniture, ornaments, cables) is estimated to be GBP 5,128,274; while the cost of removing squirrels in buildings and other properties is estimated in GBP 1,914,555 (total damage + control GBP 7,042,829) (Williams et al. 2010). Projected annual costs of grey squirrel to the Irish (Ireland and Northern Ireland) agricultural sectors is GBP 3,635,570 (€ 4,580,818) (Kelly et al. 2013). In Italy limited damage to maize crops and poplar plantations are recorded (Currado 1998; Signorile and Evans 2007). In Italy two LIFE projects for the control of grey squirrels in north (2010-2015) and central Italy (2014-2018) cost: € 1,930,00 and € 1,433,241 respectively.
2.11. How great is the economic cost of the organism currently in Europe excluding management costs (include any past costs in your response)?	NA		Grey squirrels damage to the timber industry through bark stripping in Great Britain is estimated at GBP 684,802 per annum; damage to buildings and other

			infrastructures is estimated at GBP 5,128,000 (Williams et al. 2010). Mayle and Broome (2013) give a different estimate, with economic estimates of timber revenue loss, "In 2000 the cost of grey squirrel damage to the British timber industry, based on tree loss, reduction in timber quality and reduced yield (as described above), was estimated to be up to £10 million at the end of the then current rotation for standing crops of sycamore, beech and oak (Broome A and Johnson A, unpublished)." Annual impact to forestry in Ireland (Ireland and Northern Ireland combined) from grey squirrel is estimated at GBP 3,635,570 (€ 4,580,818); damage to buildings and other infrastructures is estimated at GBP 571,487 (€720,074)
2.12. How great is the economic cost of the organism likely to be in the future in Europe excluding management costs?	massive	high	Damage in Great Britain and Ireland is expected to remain at the levels now estimated because eradication is not possible and control is not able to reduce damage. Future damage is expected in hazelnut orchards in Piedmont (Currado et al. 1987, Currado 1993). Similar cost are expected if the species will be introduced in other countries without a rapid removal of the animals.
2.13. How great are the economic costs associated with managing this organism currently in Europe (include any past costs in your response)?	major	medium	The cost of control depends on the method used (In UK poison in grey squirrel-only areas, trapping or shooting elsewhere), the trapping intensity, personnel etc. (Huxley 2003). Two reports evaluated the cost of grey squirrel management in Great Britain (Williams et al. 2010) and Ireland, extrapolating nationwide local estimates. In Great Britain, an average price of GBP 15 per hectare is estimate as control cost to protect forestry, with an estimation of GBP 5,412,518 per annum for the whole country. Grey squirrels can do serious damage inside

			lofts and a total cost of GBP 1,914,555 is estimate for removing squirrels from buildings. The annual cost of grey squirrel control as part of the red squirrel protection is estimated to GBP 611,600. The average cost of controlling grey squirrels in Northern Ireland would be GBP 2,841,300 per year and €19,579,576 per year for Ireland. In Italy two LIFE projects for the control of grey squirrels in north (2010-2015) and central Italy (2014-2018) cost: € 1,930,00 and € 1,433,241 respectively.
2.14. How great are the economic costs associated with managing this organism likely to be in the future in Europe?	major	high	The cost for the control of grey squirrels in Great Britain and Ireland are expected to remain at the levels now estimated because eradication is not possible and thus control should be continued to reduce damage. In Italy future cost for managing the species will depends on the results of the two LIFE project but will continue because the eradication of the specie in the country is possible for most of the populations, but will require a long term strategy. Similar cost are expected if the species will be introduced in other countries without a rapid removal of the animals.
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding Europe?	moderate	medium	No damage is known from South Africa. In North America the grey squirrel could have an impact on the native American red squirrel (*Tamiasciurus hudsonicus***)** but information is still scant. In Vancouver Island (Canada), introduced grey squirrels pose a threat to sensitive Garry Oak ecosystems. They frequently bite out the tips of the cached acorns of some oaks, including Garry oaks, and may negatively affect oak regeneration. Grey squirrels can damage and kill trees, especially young oaks, by stripping the bark. Squirrels may also eat native lily bulbs such as camas (*Camassia* spp.) in Garry oak ecosystems (http://www.goert.ca/documents/InvFS_sciucaro.pdf).

2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) currently in Europe (include any past impact in your response)?	major	high	The grey squirrel threatens the native red squirrel with extinction due to resource competition (Wauters et al. 2001, 2002a, b; Gurnell et al. 2004). In Great Britain the competitive exclusion is also mediated by a squirrel poxvirus (Sainsbury et al. 2000; Rushton et al. 2006). Since the introduction of the alien species, red squirrels have gone extinct in large parts of Great Britain and in most of the area now occupied by the alien species in Piedmont, N. Italy (Gurnell et al. 2008 a,b; Bertolino et al. 2014) Bark stripping has influenced woodland management practices in England, where a shift away from trees susceptible to squirrel damage has been observed (Mayle, 2005), with an influence on the flora and fauna associated with specific woodland types. Squirrels predate eggs and fledgling of birds; further studies are required on whether they contribute to the decline of particular woodland bird species (Amar et al., 2006; Newson et al., 2010).
2.17. How important is the impact of the organism on biodiversity likely to be in the future in Europe?	major	high	If uncontrolled, the spread of the grey squirrel from Italy to France and Switzerland, and in the long term to other European countries, or the direct introduction of the species to other countries, will affect the survival of the native red squirrel. The potential impact on other species such as woodland birds or glirids is unknown but possible
2.18. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic interactions), including losses to ecosystem services, caused by the organism currently in Europe (include any past impact in your response)?	moderate	medium	Bark stripping has influenced woodland management practices in England, where a shift away from trees susceptible to squirrel damage has been observed (Mayle, 2005), with an influence on the flora and fauna associated with specific woodland types.
2.19. How important is alteration of ecosystem function (e.g. habitat change, nutrient cycling, trophic	moderate/major	medium	Bark stripping has influenced woodland management practices in England, but not in Italy. This is probably

interactions), including losses to ecosystem services, caused by the organism likely to be in Europe in the future?			related to different woodland management practices in the two countries, with more natural forests in Italy (Kenward & Parish 1986; Kenward et al. 1992; Currado 1998). This habitat change is likely to continue in the future in Britain, while in case of introductions of the grey squirrel in other countries woodland damage and alteration will depends on local management practices.
2.20. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism currently in Europe?	moderate	high	Though not included in the Habitat Directive, the extinction of the red squirrel with its replacement by the grey squirrel decreases the conservation status of many areas.
2.21. How important is decline in conservation status (e.g. sites of nature conservation value, WFD classification) caused by the organism likely to be in the future in Europe?	moderate	high	A decrease in the conservation status of many areas is expected if the red squirrel will be replaced by the grey squirrel in other parts of Scotland, Ireland, Italy and possibly in new areas of introduction.
2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious?	NA		
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	minimal	low	Not known
2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	major	very high	Vector for squirrel poxvirus which causes a lethal disease in native red squirrels (Tompkins et al. 2002) Spill-over of gastro-intestinal nematode, *Strongyloides robustus* to native red squirrels occurs in Italy (Romeo et al. 2013, 2014), this may lead to parasite-mediated competition
2.25. How important might other impacts not already covered by previous questions be resulting from introduction of the organism? (specify in the comment	minimal	low	Not known

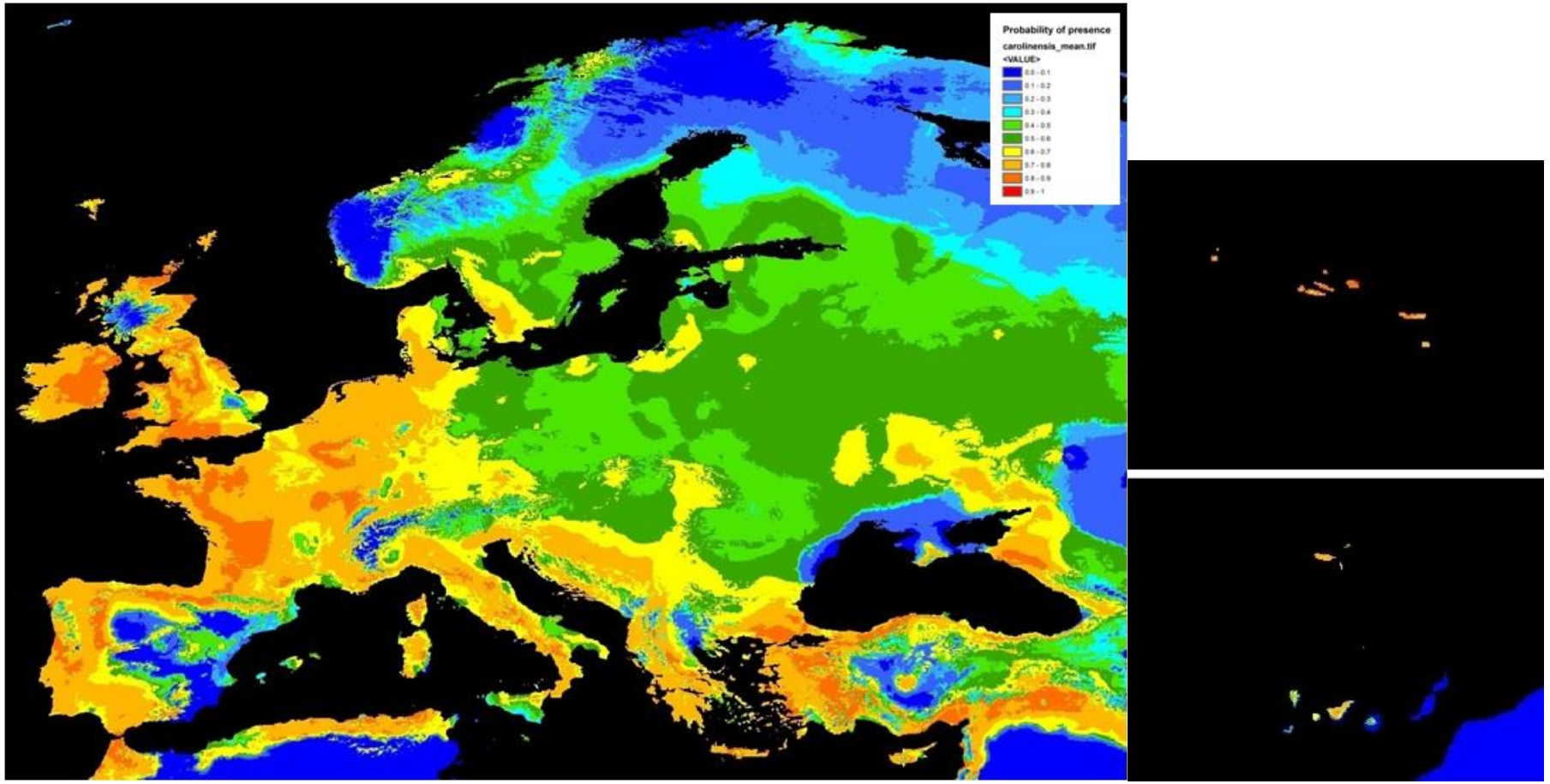
box)			
2.26. How important are the expected impacts of the organism despite any natural control by other organisms, such as predators, parasites or pathogens that may already be present in Europe?	major	medium	Predation is only rarely a major cause of mortality in grey squirrel populations (Koprowski 1994; Gurnell 1996). However, pine marten seems to have an impact in some parts of Ireland (Sheehy et al. 2014). Parasites and pathogens present in UK, Ireland and Italy do not limit the species.
2.27. Indicate any parts of Europe where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	[Most of the countries (see map)]	high	The European projection of the grey squirrel's climatic niche calculated in Maxent using records from native and invasive range predicted many highly suitable areas in a large extent of Europe (see attached map from Di Febbraro et al. 2013) including most of the European countries.

RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	likely	high	The grey squirrel is already present in Great Britain, Ireland and Italy. Both Ireland and Great Britain are islands and the main risk to the rest of Europe comes from pet trade and range expansion form Italy. Here the species is present in the northern part of the country close to the French and Swiss border and will spread in these countries (Bertolino et al. 20008) in a near future without an effective control in Italy. Management actions are ongoing in Italy despite a strong opposition from some animal right groups; considering the spread of the populations, control need to be continued for many years. The species is still traded in many European countries with the risk of new releases (UNEP-WCMC 2010).
Summarise Establishment	likely	high	The spread from Italy to other countries is likely as well as the possibility of human-mediated releases in other European countries. In such a situation, the successful establishment of new populations is highly likely. The climatic conditions in most of Europe are considered suitable for the establishment of grey squirrel populations (Di Febbraro et al. 2013). Temperate forests and woodlands in Europe have many tree species that are similar (same genus) than in the native area of grey squirrels and thus produce food resources similar in quantity and quality. The grey squirrel is a highly adaptive and opportunistic species and viable populations could establish from few founders. Animals are often released in urban parks, suburban gardens, parkland, which could provide suitable habitats with high food availability and supplementary feeding by

			humans that could help to overcome first periods with very low density; from here spread to forested habitats (deciduous, mixed and coniferous woodland) is likely considering the dispersal ability of the species (Koprowski 1994; Wauters et al. 1997; Lurz et al. 2001; Bertolino et al. 2014). Humans can further promote the spread of the species with translocation from one area to another (Shorten 1954; Martinoli et al. 2010; Signorile et al. 2014)
Summarise Spread	I moderately II rapidly	medium	I. Typical saturation dispersal of small-sized mammals; SEPD models show typical logistic growth with slow population growth and spread in the early phase after introduction, followed by rapid increase of population size and distribution range (Lurz et al. 2001; Tattoni et al. 2006; Bertolino et al. 2008). The species already spread over large areas in Great Britain, Ireland and Italy. II. Further spread of species via releases (accidental and deliberate introductions and translocations)
Summarise Impact	major	very high	Extinction of the native red squirrel (Gurnel & Pepper 1993; Gurnell et al. 2004; Bertolino et al. 2014); economic impacts to commercial forestry, damage to recreational trees and an influence on forestry tree species composition with a shift away from trees susceptible to squirrel damage and an impact on the flora and fauna associated with specific woodland types (Mayle 2005; Mayle & Broome 2013).
Conclusion of the risk assessment	high	high	A large number of scientific publications demonstrate the invasiveness of the grey squirrel, its economic impact (in Great Britain and Ireland) and mechanisms by which it replaces the native red squirrel, causing wide-scale extinction of the latter.

ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	[Climate directly]	high	Squirrel populations will increase due to increased seeding of oak and warmer winters. Considering that warmer and drier conditions seem to favour the spread of the grey squirrel, the present climate change may further benefit the species in colonising new areas (Di Febbraro et al. 2013).
3.2. What is the likely timeframe for such changes?	50 - 100 years	medium	
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	[Increase suitability of some habitats]	medium	
ADDITIONAL QUESTIONS - RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	[The species invasiveness is demonstrated by many papers]	high	Confidence in the risk assessment is high. A large number of scientific publications demonstrate the invasiveness of the grey squirrel, its economic impact (in Great Britain and Ireland) and mechanisms by which it replaces the native red squirrel, causing wide-scale extinction of the latter. The species is already established in large areas of Great Britain, Ireland and Italy. The European projections of the grey squirrel's climatic niche evaluated in Maxent show a high suitability for the species of most of Europe. Recent, parasitological studies (Romeo et al. 2013; 2014) highlighted the introduction to Italy of the Nearctic nematode *Strongyloides robustus* by grey squirrels and its subsequent spillover to the native species. The impact of this novel parasite on red squirrels (and potentially other rodents) is still unknown, but it deserves further attention, since it may potentially exacerbate the competition between the two

			sciurid species



European projections of grey squirrel's climatic niche calculated in Maxent using records from native and invasive range (Great Britain, Ireland, Italy). Maps taken from the results presented in Di Febbraro et al. (2013).

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