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REPORT ON THE METHODS TO CARRY OUT RISK ASSESSMENTS FOR MAMMALS: AN APPLICATION WITH *CALLOSCIURUS FINLAYSONII* AND *SYLVILAGUS FLORIDANUS*

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Compiled by
Mr Sandro Bertolino
on behalf of the Bern Convention

REPORT ON THE METHODS TO CARRY OUT RISK ASSESSMENTS FOR MAMMALS: AN APPLICATION WITH *CALLOSCIURUS FINLAYSONII* AND *SYLVILAGUS FLORIDANUS*

by Mr Sandro Bertolino

The new EU Regulation 1143/2014 'on the prevention and management of the introduction and spread of invasive alien species' foresee that the European Commission adopt a list of invasive alien species of Union concern ("the Union list"). The article 3 define "invasive alien species" as an alien species whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services; "invasive alien species of Union concern" means an invasive alien species whose adverse impact has been deemed such as to require concerted action at Union level. To complain with the requirements of the Regulation, the proposal of species to be listed as invasive alien species of Union concern, should be based on the preparation of a Risk assessment.

METHODS TO CARRY OUT RISK ASSESSMENTS FOR MAMMALS

Mammals are generally considered good invaders, with a high establishment success and the possibility to produce harms to biodiversity and human well-being (Nentwig et al. 2010); Kumschick et al. 2011). The mammals introduced in Europe were reviewed by Genovesi et al. (2009) analysing the information collected during the DAISIE project (www.europe-aliens.org). The database reported a list of 88 mammal species introduced since year 1500 in one or several of the 52 European geographic entities considered for the data collection (43 countries, including Russia, and nine islands). The most frequent pathway of introduction in Europe resulted the intentional release from captivity, which accounts for 35% of all known cases. Activities related to invasions were mainly fur farming (15% of all cases), hunting 21%, release or escape of pets 10%, and escapes from zoos 6%. The pathways of introduction have changed in the last centuries, with a decrease in the role of unintentional transport, and an increase of escapes and of the spread of established populations. This analysis was expanded with a resulting list of 117 species by Genovesi et al. (2012), with data on introductions that have taken place since Neolithic times. The authors also reported a severe impact of alien mammals to biodiversity, with 27 introduced species affecting 131 native species, 45 of them considered threatened according to the IUCN Red List.

Assessing invasion risk relies on identifying factors that are linked to 1) the successful establishment and spread if a new species is released or escapes from containment; 2) the risk of adverse impacts that could be classified into three main categories: economic, environmental and social (Bomford 2008). It should be kept in mind that a risk assessment procedure cannot determine whether or not an introduced exotic species will establish and spread and what impact it will have. Aim of the risk assessment is to estimate the "likelihood" that a species will establish and spread and its potential to cause harm. Therefore, every single evaluation should be accompanied by an assessment of its confidence, from low to very high, based on the information available for the species. Data from previous introductions are useful to improve the level of confidence of the evaluations and to support the assessment.

Roy et al. (2014) in a framework for the identification of invasive alien species of EU concern, developed the minimum standards criteria for risk assessment. Among the reviewed methodologies the GB NNRA, EPPO DSS, Harmonia and ENSARS were the risk assessment protocols that most closely met the minimum standards. The protocols evaluate for a given species the probability of entry in the risk-assessment area (Europe), indicating possible pathways, the probability of establishment, the expected spread and the probability of relevant impacts.

Evaluating the establishment success for a taxonomic group is not an easy task. This is because usually failures are less reported in the literature in respect to success, this leads to an overestimation of the establishment success rate (Jeschke 2008; Rodriguez-Cabal et al. 2009). However, comparing success and failure Forsyth et al. (2004) and Bomford et al. (unpublished data, reported in Bomford 2008) found that, relative to failed species, successfully established mammal species: have higher average climate matches to the countries where they were introduced, have larger average world geographic range sizes, are more likely to have established exotic populations elsewhere, were introduced more times. In more detail, Bertolino (2009) considering the worldwide squirrel introductions, found that the main vector for these mammals is the intentional importation of live animals. Introductions increased in developed countries and proportionately to the volume of imported mammals. Moreover, areas characterized by higher numbers of native squirrels were more invaded. The likelihood of establishment increased proportionately to the number of animals released and decreased proportionately to the increase of the latitudinal distance between the recipient area and the native range of the species. Overall, the likelihood that the release of one pair of either *Sciurus* or *Callosciurus* species would establish a new population was higher than 50%.

RISK ASSESSMENTS FOR FINLAYSON'S SQUIRREL *CALLOSCIURUS FINLAYSONII* AND EASTERN COTTONTAIL *SYLVILAGUS FLORIDANUS*.

The Finlayson's squirrel and the Eastern cottontail are two mammals already introduced in Europe. The Finlayson's squirrel is an arboreal rodent native to South East Asia that has been introduced in Italy; outside Europe introduced populations are present in Japan, Singapore and Philippines. In Italy the species is present with two populations: one localized in the city of Acqui Terme and in the surroundings; the second was introduced in the South of the country and it is now rapidly spreading along the Tyrrhenian cost. The Eastern cottontail is native to America, from Southern Canada through the eastern and south-eastern United States, Mexico, Costa Rica, Colombia and Venezuela. In Europe this species was introduced in Italy, France, Belgium, Spain, Luxembourg and Switzerland (DAISIE web-site) for hunting purposes, but in recent times wild populations have only survived in Italy. Here the Eastern cottontail is established in a large area in the northwestern part of the country that includes most of the Piedmont and the western part of Lombardy, with smaller populations located in other regions (Trocchi & Riga 2005; Bertolino et al. 2011b).

The form used for the risk assessment of these two species is the EUROPE NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME that derives from the Great Britain Non-Native Risk Assessment (GB NNRA) with an update (e.g. additional questions on the effects of climate change on the evaluated species and its impacts on ecosystem services) to accomplish with the minimum standards criteria for risk assessment established by Roy et al. (2014). This new European–wide risk assessment form was previously used to assess other mammals, e.g. *Sciurus carolinensis*, *Callosciurus erythraeus*, *Myocastor coypus*; these assessments were considered to compliant with the minimum standards (Roy & Scalera 2015).

One problem that can lead to a bias in evaluating risks of species establishment and impacts is that literature reviews are often restricted to publications in English and global coverage is often neither complete nor uniform across continents (Hayes & Sliwa 2003). For the risk assessments here considered, the literature review included published papers and grey literature in English, Italian, and French.

MAIN CONCLUSIONS OF RISK ASSESSMENTS

Eastern cottontail *Sylvilagus floridanus*

1. Entry - Response: very likely; Confidence: very high

The species is already present in the Risk Assessment area with viable and spreading populations in Italy. From Italy it could spread in other countries. Another pathway for new introductions is the release of animals for hunting. The species has been already released for hunting in many countries (France, Spain, Belgium, Italy, Luxembourg and Switzerland outside EU28). Though in the past it has established viable population only in Italy, habitats are suitable in most of Europe; therefore future introductions could be successful. In Italy the species is widely distributed in the north-western of the country. Herein, the species has dramatically expanded its range in the last fifteen years and population densities increased in many areas (Bertolino et al. 2011c). Therefore, an expansion to France and Switzerland in the medium term is possible (Chapuis et al. 2003).

2. Establishment - Response: very likely; Confidence: very high

The Eastern cottontail is already established in Italy in a large area in the northwestern part of the country that includes most of the Piedmont and the western part of Lombardy regions and with smaller populations located in other regions (Trocchi & Riga 2005; Bertolino et al. 2011c). The Eastern cottontail has the widest distribution of any species of *Sylvilagus* (Chpaman et al. 1980), being present in the native range from northern South America to Southern Canada. In such a wide range the species is adapted to a variety of habitats and is considered a generalist species. General requirements are for open habitats close to high vegetation or shrub and hedgerows that provide shelters. Cottontail food habits vary greatly depending upon the geographic region and the availability of species (Chapman et al. 1982). Nearly every kind of grass, succulent herb, or flowering plant, could be consumed by the cottontail (Sweetman 1944; Chapman et al. 1980). Most of Europe is within the latitudinal range of the specie in America and host similar habitats. The species is adapted to cultivated landscapes, typical of most European lowlands. The possibility to establish further viable populations are increased by the high reproductive rate. The native range of the Eastern cottontail comprises warm temperate areas, moist and dry, with an extension in cool temperate zone in the North and tropical climate in the South. Therefore, Mediterranean, Continental and Atlantic biogeographic regions are areas were the species could potentially establish in Europe. According to Arthur (1984) the Eastern cottontail disappeared from France due to its sensitivity to predation or pathogens (pseudo-tuberculosis). These possible limiting factors should, however, be better investigated, even considering that instead in Italy the species is spreading and seems not limited.

3. Spread - Response: moderately; Confidence: medium

The species is already established in Italy; however, quantitative studies on the spread are not available. In the province of Alessandria (Piedmont region), the range recorded at a municipality level increased linearly from 14 municipalities in 1995 to 83 in 2003, with a six-fold increase (Bertolino et al. 2011c). In the medium term, the species could colonize areas where the borders with France is at low altitude (southern Piedmont, western Liguria) and then surmountable by cottontails that will have the possibility to spread in this country (Chapuis et al. 2003). From Lombardy the species could enter the canton Ticino in Switzerland. The species has been introduced in some European countries for hunting in years 1950-1990. These introduction attempts have been in an effort to establish alternate game species for native rabbits and hares. Though new introductions are not reported, animals can be released again, especially as a replacement of hares and rabbits where they disappear or are at low densities. These introductions potentially create new propagules and could help the species to overcome ecological barriers and increase the spread rate.

4. Impact - Response: moderate; Confidence: medium

Research conducted in captivity and in enclosures in France highlighted the risks of crop damage and possible space and food competition with other lagomorphs (Arthur & Chapuis 1983; Chapuis et al. 1985). In North America, the Eastern cottontail seems to compete with the native *S. transitionalis* in areas of introduction (Probert and Litvaitis 1996; Chapman, & Ceballos 1990). A niche differentiation between the Eastern cottontail and the native European hare has been observed in northern Italy (Bertolino et al. 2011b; Vidus-Rosin et al. 2009, 2012; Bertolino et al. 2013), suggesting that habitat partitioning could avoid or reduce competition between the two species. Similar studies are not available for the European rabbit. Cottontail herbivory damages shrubs and trees by eating all of the inner bark from around the trunk and chewing exposed roots. Damage are reported in orchards and poplar plantations (Chapman et al. 1982; Chapuis et al. 1985; Spagnesi 2002). Cottontails can also change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance. The cottontail is also a possible vector of parasites and diseases that can harm native species and potentially humans.

5. Conclusion of the risk assessment - Response: moderate; Confidence: medium

The species is already present in the Risk Assessment area with viable and spreading populations in Italy. From Italy it could spread in other countries. Another pathway for introductions is the release of animals for hunting. The species has been already released for hunting in other European countries. Though in the past it has established viable population only in Italy, habitats are suitable in most of Europe; therefore future introductions could be successful. In case of new introductions in the Mediterranean, Continental and Atlantic biogeographic regions, the likelihood of establishment is medium to high and the spread could be from slowly to moderate, depending on the habitat. Possible impacts regard the competition with other lagomorphs, though first results show a habitat partitioning with the European hare. Damage to crop and natural vegetation could be important in areas of high densities, overgrazing by cottontails can also change the composition of plant communities. The cottontail is also a possible vector of parasites and diseases that can harm native species and potentially humans.

6. Need for more research

Confidence in the risk assessment is medium too high for establishment and spread. Information on damage and impact to biodiversity is still limited and further research is needed to better clarify the role of the species in European ecosystems. Long-term demographic studies and/or experimental manipulations are required to better evaluate the population interactions between the Eastern cottontails and the native lagomorphs. Further studies are also necessary to clarify the possible role of the species as vector of parasites and diseases that can harm native species and potentially humans and if pathogens and predators could act as limiting factors for cottontails.

Finlayson's squirrel *Callosciurus finlaysonii*

1. Entry - Response: very likely; Confidence: very high

C. finlaysonii is already present in the Risk Assessment area because it was introduced twice in South and North Italy (Bertolino & Lurz 2013). The primary pathway for entry involves the escapes/releases of animals maintained in 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 and is already kept in wildlife parks, private collections and pet shops.

2. Establishment - Response: very likely; Confidence: very high

The species is already established in Italy (Bertolino & Lurz 2013); introduction in other countries is possible as the species is traded in Europe. According to the climatic matching between the native range and the Risk Assessment area, the specie could adapt to countries in the Mediterranean region and possibly to the southern parts of the Continental region. *C. finlaysonii* is an adaptive and opportunistic species and viable populations could establish from few founders (Bertolino 2009). In the native range this arboreal species occurs in the tropical and subtropical broadleaf forests, open woodland and plantations (Lurz 2014); it is very tolerant to woodland degradation and fragmentation (Duckworth et al. 2008). In Italy the species adapted to Mediterranean deciduous forests and Mediterranean pine forests (Bertolino et al. 2004; Aloise and Bertolino 2005; Rima et al., 2007). It is also found in urban and suburban areas where it benefits from supplemental feeding (Bertolino et al. 2004; Bertolino & Lurz 2013). In the two introduction areas in Italy, as well as in Singapore, the animals were released in urban and suburban parks which could provide suitable habitats with high food availability and supplementary feeding by humans that could help to overcome first periods with few animals and allow to reach high densities (Bertolino et al. 1999; Bertolino & Lurz 2013). Animals could then spread from urban areas to more natural environments.

3. Spread - Response: moderately; Confidence: medium

The spread of arboreal squirrels is through active saturation dispersal, mainly of immature individuals, which will colonize new areas of suitable habitat. Quantitative studies on the spread rate are not reported for this species; however, the spread in South Italy was rapid after an initial lag-phase and animals tripled the range in four years. In case of new introductions in other countries in the Mediterranean area the likelihood of establishment is high and the spread could be from slowly to moderate, depending on the habitat. Humans can promote the spread of the species with translocation from one area to another (Aloise & Bertolino 2005; Aloise et al. 2011).

4. Impact - Response: major; Confidence: medium

The magnitude of present and future impacts will depends on the results of the ongoing management activity in South Italy. However, these actions are geographically limited in respect to the range of the species, and the possible establishment of new populations. In Italy the most evident damage caused by *C. finlaysonii* is bark stripping. Damage can be important, though not yet quantified in economic term. Bark stripping increases the risk of fungal infections and invertebrate damage, which can reduce timber yield (Mayle 2010). Damage to electric cable and other manufacture are also reported (Aloise & Bertolino 2005; Aloise et al. 2011). The species is considered a frequent predator of birds' nests in its native range (Bertolino & Lurz 2013), but there are no information for the introduced range (Bertolino & Lurz 2013). Transmission of pathogens could likely cause a risk but, currently, it is not documented. The potential impact on other species such as the red squirrel, woodland birds or glirids is unknown but likely, especially considering the impacts due to other alien squirrels introduce in Europe (i.e. *Sciurus carolinesis*, *Tamias sibiricus*, *Callosciurus erythraeus*).

5. Conclusion of the risk assessment - Response: high; Confidence: medium

C. finlaysonii is already present in Italy and the population in the South is rapidly spreading in recent years. The primary pathway for entry involves the escape or deliberate release of animals from captivity and the species is traded in Europe; therefore new releases are likely. In case of new introductions in other countries the likelihood of establishment is high in the Mediterranean area and the spread could be from slowly to moderate, depending on the habitat. Damage through bark stripping can be important. Data on impacts on native species are missing; however considering the impact caused by other alien squirrels introduced in many European countries, interspecific competition is likely.

6. Need for more research

Confidence in the risk assessment is medium to high for establishment, spread and damage to forestry and plantations. *C. finlaysonii* is already present in Italy with two populations established about thirty years ago; the one in the South is rapidly spreading in recent years after an initial lag phase. In both areas, bark-stripping damage occurs and is important. Data on the possible impacts on native species are absent, for the lack of specific studies. Considering the impacts due to other alien squirrels introduced in Europe (e.g. *Sciurus carolinesis* and *Callosciurus erythraeus* competing with the native red squirrel), the possible impacts of *C. finlaysonii* on native species and ecosystems should be investigated to better evaluate the level of invasiveness of the species. For the same reasons, the possible role of the species in disease transmission, with introduced individuals acting as vectors for parasites and diseases that can harm native wildlife (and potentially humans) should be considered. The outcomes of the ongoing control program should be published to better evaluate costs and effectiveness of these management actions.

THE TAXONOMIC STATUS OF THE MONGOOSE INTRODUCED INTO CROATIA

The small Indian mongoose has been introduced into the Balkans in the Adriatic sea on several islands and on the mainland in the Pelješac Peninsula. It is currently spreading along the Dalmatian coast and has reached the Neretva River in the north and Albania in the south (Barun et al. 2008, 2010, 2015; Ćirović et al. 2011). The species in the Adriatic has been called with several scientific names in the literature (reviewed by Bird 2015). Tvrtković and Kryštufek (1990), with a morphological study, and Veron et al. (2007), by using molecular analysis based on mtDNA genes, attributed the species to *Herpestes auropunctatus*.

The specific status of *Herpestes auropunctatus* has been the object of a long-standing dispute. In the Mammal Species of the World: A Taxonomic and Geographic Reference (Wilson & Reeder 2005), the book used as reference by most mammalogists, *Herpestes auropunctatus* is considered conspecific with *Herpestes javanicus* (Wozencraft 2005). Wozengraft (2005) revised the literature that considered *H. auropunctatus* as a subspecies of *H. javanicus (e.g.* Bechthold 1939; Lekagul & McNeeley 1977; Corbet & Hill 1992) or as a separate species (e.g. Wenzel & Haltenorth 1972; Nellis 1989; Taylor & Matheson 1999). At the end, he followed Wenzel and Haltenorth (1972) and Corbet and Hill (1992) considering the taxa *auropunctatus* and *javanicus* conspecific as *H. javanicus*.

Taylor and Matheson (1999), on the basis of a morphometric analysis, recognised two separate species, with specimens from Java, Vietnam and Thailand as *H. javanicus*, and those from Kashmir, India, Pakistan and China as *H. auropunctatus*. On the contrary, Simberloff et al. (2000) considered the two taxa to be conspecific (*H. javanicus*) explaining differences in size between the populations in the western (Middle East, toward Bangladesh) and in the eastern (Southeast Asia) parts of the range as a result of competition. In the western parts of its native range, the species is sympatric with one or both of two slightly bigger mongooses: the Indian grey mongoose *H. edwardsii* and the ruddy mongoose *H. smithii*. The authors showed that *H. javanicus* is bigger in the parts of the native range where the two congeners are absent, explaining this morphological change resulting from the avoidance of competitively induced selection (Simberloff et al. 2000).

In order to clarify the systematic status and to define the limits of the ranges of these taxa, Veron et al. (2007) used Cytochrome *b* sequences obtained from 27 specimens (18 *H. auropunctatus*/*H. javanicus* and 9 *H. edwardsii*) and localities of 392 specimens from museum collections to determine and map the taxa. The molecular results support the existence of three distinct clades, which correspond to the Javan mongoose *Herpestes javanicus* (Southeast Asia), the small Indian mongoose *H. auropunctatus* (Central Asia, from the Middle East to Myanmar) and the grey mongoose *H. edwardsii* (largely in sympatry with *H. auropunctatus*, but not with *H. javanicus*) with a mean genetic divergence of 5% between each pair of species. The Salween River in Myanmar may act as a potential geographical barrier, with *H. auropunctatus* occurring west and *H. javanicus* east. The study supports a sister relationship between *H. javanicus* and *H. edwardsii* and not between *H. javanicus* and *H.*

auropunctatus, invaliding the definition of *H. javanicus sensu* Wozencraft (2005). The authors suggested that the conclusions on interspecific competition and character release in small Asian mongooses proposed by Simberloff et al. (2000) should be reconsidered, as the taxa investigated would be composed of three species rather than two. The authors, however, caution about their results being based only on a mitochondrial marker, with divergences between the three clades obtained being close to the intraspecific variation level, and suggest that the specific status remains to be confirmed by the analysis of nuclear makers.

Patou et al. (2009) performed a study on the molecular phylogeny of the mongooses (Carnivora, Herpestidae). They used mitochondrial (Cytochrome b and ND2) and nuclear (b-fibrinogen intron 7 and Transthyretin intron 1) sequences from ten out of the eleven recognized *Herpestes* species (excluding *H. semitorquatus*) to produce a phylogeny of the Herpestidae. They also performed molecular dating analyses to infer divergence dates of the different lineages within the Herpestidae. The study confirmed that the genus *Herpestes* is paraphyletic: the two African species (*H. naso* and *H. ichneumon*) and the monophyletic Asian *Herpestes* clade belong to three distinct lineages. The Asian *Herpestes* mongooses form a monophyletic group, suggesting a unique Asian ancestor for all these species. *Herpestes javanicus* and *H. auropunctatus* formed two distinct and well-supported clades, as was previously found by Veron et al. (2007). Therefore *H. auropunctatus* and *H. javanicus* remain distinct species when mitochondrial or nuclear data are considered. The authors also found a conflict between mitochondrial and nuclear signals concerning the *H. auropunctatus*/*H. edwardsii*/*H. javanicus* species complex. *Herpestes javanicus* resulted a sister-taxon to *H. edwardsii* if using mitochondrial data, but by using nuclear data a different phylogenetic pattern was recovered, with *H. javanicus* more closely related to *H. auropunctatus* than to *H. edwardsii*. This could probably be explained by ancient interspecific hybridization. Furthermore, considering that the Asian *Herpestes* group exhibits a relative morphological homogeneity, a geographical unity, and strong molecular evidence for their monophyly, suggesting the placement of all Asian *Herpestes* species into one newly defined genus, Patou et al. (2009) suggest the generic name "*Urva"* Hodgson, 1837 for Asian mongooses.

The new reference book for mammals - the Handbook of the Mammals of the World Volume I: Carnivores (Wilson & Mittermeier 2009) - consider these molecular studies, reporting under the two species: 'some authors considered the small Indian mongoose and the Javan mongoose (*H. javanicus*) conspecific under the name *H. javanicus* or H. *auropunctatus*. Recent molecular studies suggest that they should be treated as separate species'. The small Indian mongoose, *Herpestes auropunctatus* Hodgson, 1836, is distributed in Asia from Iraq and Iran to Afghanistan, Pakistan, India, Nepal and Bangladesh, Myanmar, and South Cina (including Hainan Island); it has been introduced in many places, including Croatia. The Javan mongoose, *Herpestes javanicus* (*Ichneumon javanicus* Geoffroy Saint-Hilaire, 1818), is present in mainland SE Asia, Peninsula Malaysia, and Sumatra; it has been introduced to some Indonesian islands.

In conclusion, according to morphometric analysis (Taylor & Matheson 1999) and genetic studies with mitochondrial and nuclear sequences (Veron et al. 2007; Patou et al. 2009), *Herpestes javanicus* and *H. auropunctatus* should be considered two distinct species, both considering mitochondrial or nuclear data. Furthermore, Patou et al. (2009) considering the monophyly of the Asian group of mongooses suggested to change the generic name of these species from *Herpestes* to *Urva*.

The small Indian mongoose present in the Balkans has been identified as *Herpestes auropunctatus* (Tvrtković & Kryštufek 1990; Veron et al. 2007), which is now recognised as a valid species. The species has been already proposed to be included in the first list of invasive alien species of Union concern. The risk-assessment was compiled by Pablo Ferreras from the Spanish National Research Council. In the risk-assessment the name of the organism is *Herpestes javanicus*. The taxonomic entity of the introduced species is discussed in the Section A – Organism Information and Screening:

Answer to Question 1: "According to ITIS (Interagency Taxonomic Information System), *Herpestes javanicus* (É. Geoffroy Saint-Hilaire, 1818). EN: Small Asian Mongoose, Javan Mongoose, Small Indian Mongoose."

Answer to Question 2: "according to UICN, Synonym: *Herpestes palustris* Ghose, 1965. Wozencraft (2005) considered *Herpestes auropunctatus* to be conspecific with *Herpestes javanicus*, but Taylor and Matheson (1999) and Veron *et al*. (in press) suggest a specific status. *H. palustris* is considered conspecific with *H. auropunctatus* (under *H. javanicus*) by Wozencraft (2005)."

The fact that the species can be listed as invasive alien species of Union concern only with the name *Herpestes javanicus* É. Geoffroy Saint-Hilaire, 1818 - while for possible synonyms the risk assessment should be considered - may produce some confusion that, in my opinion, should be considered by who is working on the implementation of the EU Regulation 1143/2014 on Invasive Alien Species. Further confusion may be produced with the proposed name of "*Urva auropunctatus*", already used in recent publications.

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EUROPE NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: *Callosciurus finlaysonii*
Author: Sandro Bertolino
Reviewed by Lucas Wauters.
Risk Assessment Area: European Union (28 Countries)

Draft: *25/09/2015*

EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	Italy
2. In how many EU member states has this species currently established populations? List them.	Italy
3. In how many EU member states has this species shown signs of invasiveness? List them.	Italy
4. In which EU Biogeographic areas could this species establish?	According to the climatic matching between the native range and the risk assessment area, the specie could adapt to the Mediterranean region and possibly to the southern parts of the Continental region.
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.	Portugal, Spain, France, Italy, Slovenia, Croatia, Greece, Malta, Cyprus
6. In how many EU member states could this species become invasive in the future [given current climate] (where it is not already established)?	Portugal, Spain, France, Slovenia, Croatia, Greece, Malta, Cyprus

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 finlaysonii* (Horsfield 1824) EN: Finlayson's Squirrel; IT: Scoiattolo di Finlaysoni; D**:** Finlayson-Hörnchen; F: Écureuil de Finlayson; NL: finlaysonklappereekhoorn	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 or for EU28. A Risk Assessment has been conducted for Italy and Belgium. In Italy using 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: 2 (moderate). In Belgium the result was that the species has high potential of establishment and dispersal (ISEIA score 11 out of maximum 12; risk category: black list; http://ias.biodiversity.be/species/show/127)
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	No	Those available consider only single countries.
5. Where is the organism native?		South East Asia
6. What is the global distribution of the organism (excluding Europe)?		The native range of *C. finlaysonii* is thorough central Myanmar, Thailand, Laos, Cambodia and Vietnam (Moore & Tate 1965; Wilson & Reeder 2005; Duckworth et al. 2008). The species was introduced in Italy, Singapore e Philippine (Bertolino & Lurz 2013). Some of the animals present at Hamamatsu (Japan) that previously were

		considered to be C. erythraeus in fact carry mtDNA of *C. finlaysonii* (Oshida et al. 2007). The introduction of *C. finlaysonii* to Japan was confirmed by further work by Kuramoto et al. (2012).
7. What is the distribution of the organism in Europe?		The species is present with two populations in northern and southern Italy. In the North the species is present in the city of Acqui Terme (Bertolino et al. 1999), with some records also in the surroundings. In the South the species was introduced in the city of Maratea; after an initial lag-phase it is now rapidly spreading along the Tyrrhenian cost in both directions (south and north) along an area that overlooked 19 km of coastline in 2004 (Aloise & Bertolino 2005), rose to 45 km in 2004 (Aloise & Bertolino 2008; Aloise et al. 2010). The animals were recorded up to an altitude of 1,000 m and the total colonized area was 26 km^2 in 2005 (Aloise & Bertolino 2005), rose to 68 km^2 in 2008 Aloise et al. 2010).
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes	Data on the ecological impact of the species are scanty, but proper studies are still lacking. *C. finlaysonii* is considered a frequent predator of birds' nests in its native range (Bertolino & Lurz 2013). In the areas of introduction it produces large damage to trees through bark stripping and the species may cause an impact to natural vegetation (Bertolino et al. 2004; Mori et al. 2015). Bark stripping increases the risk of fungal infections and invertebrate damage, which can reduce timber yield. In Northern Italy, the extent of the damage produced by squirrels was so high that a phytosanitary cutting of 42 out of 308 trees present in an urban park where animals were first introduced was necessary (Mori et al. 2015).

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 *Callosciurus* spp. (*C. erythraeus and C. finlaysonii* were 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). Females can have 2 to even3 litters/year with 1-4 weaned young; varying percentage of adult females reproduce in a given season. In the native range this arboreal species occurs in the tropical and subtropical broadleaf forests, in diverse habitats, from primary and secondary forests to open woodlands and plantations (Lurz 2014); it is very tolerant to woodland degradation and fragmentation (Duckworth et al. 2008). In Italy the species adapted to Mediterranean deciduous forests and Mediterranean pine forests and to urban and suburban areas (Bertolino et al. 2004; Aloise and Bertolino 2005; Rima et al., 2007). In its native range *C. finlaysonii* is considered an important seed consumer and seed dispersal agent (Kitamura et al. 2004, Chanthorn et al. 2007, Suzuki et al. 2007) and also a frequent predator of birds' nests (Bertolino & Lurz 2013). In North

		Italy, squirrels were observed eating plant matter, including bark and sap, seeds and fruits, buds and flowers; animal food included insects and insect honeydew. Bark stripping by *C. finlaysonii* has been observed in Italy (Bertolino et al. 2004, Aloise & Bertolino 2005: Mori et al. 2015). Here, damage may be severe, especially in urban parks where dying trees have been cut down to reduce the risk of injury to visitors. The species is also found in urban and suburban areas where it benefits from supplemental feeding (Bertolino et al. 2004; Bertolino & Lurz 2013).
13. Does the organism occur outside effective containment in Europe?	Yes	In Italy
14. Is the organism widely distributed in Europe?	No	The species is present in Italy with two populations in the North (Bertolino et al. 1999) and in the South (Aloise & Bertolino 2005) of the country.
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 lives in Mediterranean deciduous forests and Mediterranean pine forests; it is found also in urban and suburban parks (open); (Bertolino et al. 2004; Mori et al. 2015). 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 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	In the native range this arboreal species occurs in the tropical and subtropical broadleaf forests, in diverse habitats from primary and secondary forests to open woodland and plantations (Lurz 2014); it is very tolerant to woodland degradation and fragmentation (Duckworth et al. 2008). In Italy the species adapted to Mediterranean deciduous forests and Mediterranean pine forests and to urban and suburban areas (Bertolino et al. 2004; Aloise and Bertolino 2005; Rima et al., 2007). According to the climatic matching between the native range and the Risk Assessment area, the specie could adapt to the Meditteranean region and possibly to the southern parts of the Continental region.
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 in private houses and parks, as pet-species; 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 was introduced in Italy, Singapore and Philippines (Bertolino & Lurz 2013). Some of the animals present at Hamamatsu (Japan) that previously were considered to be *C. erythraeus* in fact carry mtDNA of *C. finlaysonii* (Oshida et al. 2007; Kuramoto et al. 2012). The population in South Italy is rapidly spreading along the Tyrrhenian cost, having colonized an area of 26 km^2 by 2004 (Aloise & Bertolino 2005), rose to 68 km^2 in 2008 (Aloise & Bertolino 2008; Aloise et al. 2011). The population in North Italy is still present after thirty year from introduction, though localised in an urban area and surrounding. In Singapore, the species is slowly spreading in the city (Benjamin Lee, pers. com.)

21. Can the organism spread rapidly by natural means or by human assistance?	Yes	In general, tree squirrels have high natural dispersal capacity. In southern Italy the distribution area of *C. finlaysonii* tripled in four years (from 26 km^2 in 2005 to 68 km^2 in 2008 Aloise & Bertolino 2008; Aloise et al. 2011). Furthermore, squirrels are appealing to humans, which can promote the spread of the species with translocation from one area to another. This already happened with *C. finlaysonii* in South Italy (Aloise & Bertolino 2005; Aloise et al. 2011), *C. erythraeus* in Argentina (Guichón et al. 2005, 2015) and Japan (Miyamoto et al. 2004), *S. carolinensis* in Italy (Martinoli et al. 2010) and UK (Shorten 1954) , and with *S. stramineus* in Perù (Jessen et al. 2010). These translocations potentially create new propagules and could help the species to overcome ecological barriers and increase the spread rate.
22. Could the organism as such, or acting as a vector, cause economic, environmental or social harm in Europe?	Yes	In Italy the presence of *C. finalysonii* is linked to severe damage to trees through bark-stripping behavior, with an estimated 80% of trees damaged in an urban park in North Italy and a mean of 40% in nine wooded areas in South Italy (Mori et al. 2015). Damage to electric cables and other manufactures are also reported (Aloise & Bertolino 2005; Aloise et al. 2011). Alien tree squirrels have been linked to the introduction of novel parasites and diseases including the spread of zoonotic disease (e.g. Dozière et al. 2010; Bertolino & Lurz 2013; Romero et al., 2014, 2015). Whilst currently data for *C. finlaysonii* are scanty due to a lack of studies, the risk of disease transmission, and introduced individuals acting as vectors for parasites and diseases that can harm native wildlife (and potentially humans) should be considered

		(Lurz 2014). *C. finalysonii* sampled in pet-store in Italy resulted positive for *Dicrocoelium dendriticum* (d'Ovidio et al. 2014) that could infect also humans (Gualdieri et al. 2011; Jeandron et al. 2011). A study on animals culled in South Italy searched for fungal disease and found: *Cryptococcus neoformans*, *Debaryomyces hansenii*, *Meyerozyma guilliermondii*, *Hanseniaspora thailandica*; the last species originated from the Indochinese area and was probably introduced in Italy with the squirrels (Iatta et al. 2015).

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 Italy. 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 the escape or deliberate release of animals from captivity (see as an example of squirrel's pathway the video on YouTube regarding an illegal release of a chipmunk (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; d'Ovidio et al. 2014; see point

			1.4). Natural populations could be the source of animals for new introductions (Aloise & Bertolino 2005; Aloise et al. 2011) or for an illegal trade of the species (Signorile et al. 2014). Considering the inclusion of other exotic squirrel species (*C. erythraeus*, *S. carolinensis*, *S. niger*) in the Annexes B of the EU wildlife trade regulation 338/97, there is the possibility that the trade of *C. finlaysonii* would increase in the future.
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 (see point 1.4); 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	In the absence of any trade statistics, an internet survey was conducted between 17-21 January 2015, in order to investigate whether live *Callosciurus finlaysonii* appear to be traded within the EU, and whether there appears to be demand for these species as pets. The procedure was similar to that used by UNEP-WCMC (2010) for *Callosciurus erythraeus* and *Sciurus niger*. Adverts for the sale of *C. finlaysonii* were found on websites from Spain, Italy, Germany, Netherland; there were several advertisements for people wanting 'squirrels' in gereal and also looking specifically for *Callosciurus finlaysonii*.
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	very likely	high	It is an adaptable species. In the native range occurs in diverse habitats from primary and secondary forests to open woodland and plantations (Lurz 2014); it is very tolerant to woodland degradation and fragmentation

			(Duckworth et al. 2008). In Italy the species adapted to Mediterranean deciduous forests and Mediterranean pine forests and to urban and suburban areas (Bertolino et al. 2004; Aloise and Bertolino 2005; Rima et al., 2007). It could feed on a wide range of plant materials, i.e. nuts, seeds, tree flowers, buds, berries, as well as insects and bird eggs/nestlings (Bertolino et al. 2004; Aloise & Bertolino 2005; Bertolino & Lurz 2013). Natural populations can establish from few founders and grow quickly (Bertolino et al. 1999; Aloise & Bertolino 2005; Bertolino 2009). The species is often released in urban and suburban parks which could provide suitable habitats with supplemental feeding from humans (Bertolino et al. 1999; Aloise & Bertolino 2005; Bertolino & Lurz 2013), and from here spread to forested habitats (Aloise & Bertolino 2005).
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	likely	high	The species is already present in Italy and is traded in other European countries.
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 species is already present in Europe. 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; see also point 1.4). Natural populations could be the source of animals for translocations and an illegal trade of the species (Aloise & Bertolino 2005, Signorile et al. 2014).

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. *C. finlaysonii* is already established in Italy.			
QUESTION	**RESPONSE**	**CONFIDENCE**	**COMMENT**
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	widespread	high	In Europe the species adapted to Mediterranean deciduous forests and Mediterranean pine forests and to urban and suburban areas (Bertolino et al. 2004; Aloise and Bertolino 2005; Rima et al., 2007). It feeds mainly on plan matter, i.e. seeds, fruits, buds, flowers and sap, occasionally animal food including insects and bird eggs/nestlings. The species is also found in urban and suburban areas where it benefits from supplemental feeding (Bertolino et al. 2004; Bertolino & Lurz 2013). Therefore no single species is "vital" for its survival, development and multiplication. Suitable habitats are present and widely distributed in Southern Europe.
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	likely	medium	The dispersal capacity seems to be high; the species spread along the Tyrrhenian coast in few year in Mediterranean deciduous and pine forests and to urban and suburban areas (Bertolino et al. 2004; Aloise and Bertolino 2005; Rima et al., 2007). Established populations in Europe, Singapore and Japan originated from few animals (Bertolino 2009), thus proving the adaptability of *C. finalysonii*

			to new habitats. 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). The only control program in South Italy seems to have not spatially contained the species. Experiences form other alien squirrels 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, 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).

PROBABILITY OF SPREAD			
Important notes: **1.** 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	medium	Active saturation dispersal, mainly of immature individuals, which will colonize new areas of suitable habitat. Quantitative studies are not reported for this species; however, the spread in South Italy was rapid and after an initial lag-phase the range tripled in four years.
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	Very high	The main pathway of *C. finlaysonii* introductions in Italy has been connected to private citizens that released pet animals (Bertolino et al. 1999; Aloise & Bertolino 2005). Human assistance may amplify the potential of the species spread and at least two translocations are already reported (Aloise & Bertolino 2005; Aloise et al. 2011). 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.
2.3. Within Europe, how difficult would it be to contain the organism?	difficult	medium	The only control program is still ongoing (Ricciardi et al. 2013) and results are not available yet. From experience gained in Europe with other alien squirrels, the species could probably 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 are likely to arise because of diverse landownership patterns in control areas with possible difficulty to access private property and because of potential public opposition to control/eradication (Barr et al. 2002; Rushton et al. 2002; Anonymous 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.	[South Europe]	high	According to the climatic matching between the native range and the Risk Assessment area, the specie could adapt to the Mediterranean region and possibly to the southern parts of the Continental region. These countries are at risk of invasion: Portugal, Spain, France, Italy, Slovenia, Croatia, Greece, Malta, Cyprus
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	See distribution map in Aloise & Bertolino (2008).
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	Further expansion of the colony in South Italy. The area is however limited in respect to the overall European suitable area.
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 ten years the species could colonize a large area in Southern Italy, showing the possible adaptability to altitude and reaching areas with the presence of the native red squirrel. Therefore, its adaptability and possible competition with the native species could be evaluated in this timeframe.
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	The species would invade new areas in north and central Italy in this timeframe. This area is however limited in respect to the overall European suitable area.
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	Studies of dispersal distances are not available for this squirrel species. The only data regards the spread in southern Italy (the species tripled the colonized area in four 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.

PROBABILITY OF IMPACT

Important instructions:

2. 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.
3. 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).
4. 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	medium	In Italy the most evident damage caused by this species is bark stripping. Damage can be really important, though not quantified in economic term. Bark-stripping damage is estimated in 80% of trees damaged in an urban park in North Italy and a mean of 40% in nine wooded areas in South Italy (Mori et al. 2015). In North Italy, the extent of the damage produced by squirrels was so high that a phytosanitary cutting of 42 out of 308 trees present in the urban park where animals were first introduced was necessary. Damage to electric cable and other manufacture are also reported (Aloise & Bertolino 2005; Aloise et al. 2011). A control program is ongoing in South Italy, but information on its costs and effectiveness are not available yet. Considering previous management programs on other squirrel species costs should be high.
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		Bark-stripping damage can be really important, though not quantified in economic term.
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, bark-stripping damage could be from moderate to important. 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	A control program is ongoing in South Italy, but information on its costs and effectiveness are not available yet. Considering previous management programs on other squirrel species costs 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	medium	In Italy future cost for managing the species will depends on the results of the control plan in the South. Though, it appear that management activities consider only part of the species range, therefore present goal is not the eradication of the population but only its containment. Therefore, management should continue in the future, even in the North. If the species is not banned from Europe, the possibility of new introductions is high and therefore further management actions will be needed. In such a situation, control costs will increase exponentially with every new case of an introduced, established and spreading population
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding Europe?	minor	low	Data on the ecological impact of *C. finlaysonii* are scanty, but proper studies are still lacking. The species is considered a frequent predator of birds' nests in its native range (Bertolino & Lurz 2013), but there are no information for the introduced range. 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.
2.16. 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)?	minor	low	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 nests. There are some potential problems of predation on bird eggs/nestlings, but studies in Europe are missing and

			also from its native range there are only qualitative data (Bertolino & Lurz 2013). 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?	moderate	low	The potential impact on other species such as the red squirrel, woodland birds or glirids is unknown but possible, especially considering the impacts due to other alien squirrels introduce in Europe (i.e. *Sciurus carolinesis*, *Tamias sibiricus*, *Callosciurus erythraeus*)
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	medium	Bark stripping could influence woodland management practices (Mayle, 2005). 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	low	Though not included in the Habitat Directive, the possible interference with the red squirrel would decrease the conservation status of many areas. It should be considered that *Sciurus vulgaris meridionalisis*, localized in South Italy, is genetically highly differentiated from all other European red squirrel populations that are overall more homogeneous among them (Grill et al. 2009); therefore, this taxa should be considered at least an important conservation unit, if not a new species (Gippoliti 2013; Bertolino et al. 2015)
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	low	A decrease in the conservation status of many areas is expected if the red squirrel will be affected by *C. finlaysonii* in 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)?	minimal	low	Transmission of pathogens could likely be a risk, as for other squirrels, but it is not documented yet for this species.
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	Data from the native range are missing. Predators, parasites and pathogens present in Italy did not limit the spread of the species (Aloise & Bertolino 2005; Aloise et al. 2011).
2.27. Indicate any parts of Europe where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	[Mediterranean biogeographic areas]	medium	In Italy if the control plan will not be effective. In other countries in the Mediterranean biogeographic areas if the species will be introduced

RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	very likely	Very high	*C. finlaysonii* is already present in the Risk Assessment area because it was introduced twice in South and North Italy (Bertolino & Lurz 2013). The primary pathway for entry involves the escapes/releases of animals maintained in 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 and is already kept in wildlife parks, private collections and pet shops.
Summarise Establishment	very likely	Very high	The species is already established in Italy (Bertolino & Lurz 2013); introduction in other countries is possible as the species is traded in Europe. According to the climatic matching between the native range and the Risk Assessment area, the specie could adapt to countries in the Mediterranean region and possibly to the southern parts of the Continental region. *C. finlaysonii* is an adaptive and opportunistic species and viable populations could establish from few founders (Bertolino 2009). In the native range this arboreal species occurs in the tropical and subtropical broadleaf forests, open woodland and plantations (Lurz 2014); it is very tolerant to woodland degradation and fragmentation (Duckworth et al. 2008). In Italy the species adapted to Mediterranean deciduous forests and Mediterranean pine forests (Bertolino et al. 2004; Aloise and Bertolino 2005; Rima et al., 2007). It is also found in urban and suburban areas where it benefits from supplemental feeding (Bertolino et al. 2004; Bertolino & Lurz 2013).

			In the two introduction areas in Italy, as well as in Singapore, the animals were released in urban and suburban parks which could provide suitable habitats with high food availability and supplementary feeding by humans that could help to overcome first periods with few animals and allow to reach high densities (Bertolino et al. 1999; Bertolino & Lurz 2013). Animals could then spread from urban areas to more natural environments.
Summarise Spread	moderately	medium	The spread of arboreal squirrels is through active saturation dispersal, mainly of immature individuals, which will colonize new areas of suitable habitat. Quantitative studies on the spread rate are not reported for this species; however, the spread in South Italy was rapid after an initial lag-phase and animals tripled the range in four years. In case of new introductions in other countries in the Mediterranean area the likelihood of establishment is high and the spread could be from slowly to moderate, depending on the habitat. Humans can promote the spread of the species with translocation from one area to another (Aloise & Bertolino 2005; Aloise et al. 2011).
Summarise Impact	major	medium	The magnitude of present and future impacts will depends on the results of the ongoing management activity in South Italy. However, these actions are geographically limited in respect to the range of the species, and the possible establishment of new populations. In Italy the most evident damage caused by *C. finlaysonii* is bark stripping. Damage can be important, though not yet quantified in economic term. Bark stripping increases the risk of fungal infections and invertebrate damage, which can reduce timber yield (Mayle 2010). Damage to electric cable and other manufacture are also reported (Aloise & Bertolino

			2005; Aloise et al. 2011). The species is considered a frequent predator of birds' nests in its native range (Bertolino & Lurz 2013), but there are no information for the introduced range (Bertolino & Lurz 2013). Transmission of pathogens could likely cause a risk but, currently, it is not documented. The potential impact on other species such as the red squirrel, woodland birds or glirids is unknown but likely, especially considering the impacts due to other alien squirrels introduce in Europe (i.e. *Sciurus carolinesis*, *Tamias sibiricus*, *Callosciurus erythraeus*).
Conclusion of the risk assessment	high	medium	*C. finlaysonii* is already present in Italy and the population in the South is rapidly spreading in recent years. The primary pathway for entry involves the escape or deliberate release of animals from captivity and the species is traded in Europe; therefore new releases are likely. In case of new introductions in other countries the likelihood of establishment is high in the Mediterranean area and the spread could be from slowly to moderate, depending on the habitat. Damage through bark stripping can be important. Data on impacts on native species are missing; however considering the impact caused by other alien squirrels introduced in many European countries, interspecific competition is likely.

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 finlaysonii* initially originate from tropical and subtropical broadleaf forests in Asia; due to their flexibility, they were also able to colonize Mediterranean deciduous and pine forests and urban and suburban areas (Bertolino & Lurz 2013). According to the present climatic matching between the native range and the risk assessment area, the specie could adapt to Mediterranean region and possibly to the southern parts of the Continental region (/e.g. North Italy). Considering that warmer and drier conditions seem to favour the establishment of the species, the present climate change may further benefit *C. finlaysonii* in colonising new areas north to the Mediterranean.
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 but relations with native species should be investigated]	high	Confidence in the risk assessment is medium to high for establishment, spread and damage to forestry and plantations. *C. finlaysonii* is already present in Italy with two populations established about thirty years ago; the one in the South is rapidly spreading in recent years after an initial lag phase. In both areas, bark-stripping damage occurs and is important. Data on the possible impacts on native species are absent, for the lack of specific studies. Considering the impacts due to other alien squirrels introduced in

			Europe (e.g. *Sciurus carolinesis* and *Callosciurus erythraeus* competing with the native red squirrel), the possible impacts of *C. finlaysonii* on native species and ecosystems should be investigated to better evaluate the level of invasiveness of the species. For the same reasons, the possible role of the species in disease transmission, with introduced individuals acting as vectors for parasites and diseases that can harm native wildlife (and potentially humans) should be considered. The outcomes of the ongoing control program should be published to better evaluate costs and effectiveness of these management actions.

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EUROPE NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: ***Sylvilagus floridanus***
Author: Sandro Bertolino
Reviewed by Lucas Wauters, Jacopo Cerri
Risk Assessment Area: European Union (28 Countries)

Draft: *25/09/2015*

EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	France, Spain, Belgium, Italy, Luxembourg and Switzerland outside EU28
2. In how many EU member states has this species currently established populations? List them.	Italy
3. In how many EU member states has this species shown signs of invasiveness? List them.	Italy
4. In which EU Biogeographic areas could this species establish?	The native range of the Eastern cottontail comprises warm temperate areas, moist and dry, with an extension in cool temperate zone in the North and tropical climate in the South. Therefore, Mediterranean, Continental and Atlantic biogeographic regions are areas were the species could potentially establish.
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.	Portugal Spain, France, Italy, Slovenia Croatia, Belgium, Netherlands, Germany, Czech republic, Slovakia, Romania Bulgaria, Greece, lowlands Austria, Cyprus, 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)?	Portugal Spain, France, Slovenia Croatia, Belgium, Netherlands, Germany, Czech republic, Slovakia, Romania Bulgaria, Greece, lowlands Austria, Cyprus, Malta

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?	*Sylvilagus floridanus* (J.A. Allen, 1980) EN: Eastern Cottontail; D: Östliches baumwollschwanzkaninchen; ES: Conejo de cola de algodón de Florida; FI: Floridanjänis; FR: Lapin de Floride: IT: Silvilago	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	
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	NA	
5. Where is the organism native?		America, from Southern Canada through the eastern and south-eastern United States, Mexico, Costa Rica, Colombia and Venezuela,
6. What is the global distribution of the organism (excluding Europe)?		In Europe it was introduced in Italy, France, Belgium, Spain, Luxembourg and Switzerland (Long 2003; Trocchi & Riga 2005; DAISIE 2008; Scalera Riccardo pers. com.) for hunting purposes, but in recent times wild populations have only survived in Italy (DAISIE 2008). The species has been the subject of widespread introduction programs in North America outside the native range (Chapman et al. 1980).
7. What is the distribution of the organism in Europe?		The Eastern cottontail is established in Italy in a large area in the northwestern part of the country that includes most of the Piedmont and the western part of Lombardy, with smaller populations located in other regions: Venetia, Friuli, Liguria, Emilia

		Romagna, Tuscany and Umbria. The distribution is mapped in Trocchi & Riga (2005) and Bertolino et al. (2011c). The species was introduced in the 1970s in southern France where it remained with reproductive populations for 10-15 years, before going extinct (Chapuis et al. 2003).
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes	Research conducted in captivity and in enclosures in France highlighted the risks of crop damage and possible space and food competition with other lagomorphs (Arthur & Chapuis 1983; Chapuis et al. 1985). A niche differentiation between the Eastern cottontail and the native European hare (*Lepus europaeus*) has been observed in northern Italy (Vidus Rosin et al. 2012), both for daytime refuges (Bertolino et al. 2011b) and for nocturnal feeding areas (Bertolino et al. 2013), suggesting that habitat partitioning could avoid or reduce competition between the two species. Similar studies are not available for European rabbit (*Oryctolagus cuniculus*). Long-term demographic studies and/or experimental manipulations research are, however, required to better evaluate the population interactions between the Eastern cottontails and the European hare. In North America, the Eastern cottontail seems to compete with the native *S. transitionalis* in areas of introduction (Probert and Litvaitis 1996; Chapman, & Ceballos 1990). Cottontail herbivory could damages shrubs and trees by eating all of the inner bark from around the trunk and chewing exposed roots. Damage is reported in orchards and poplar plantations (Chapman et al. 1982; Chapuis et al. 1985; Spagnesi 2002). Cottontails can also change the

		composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance. The cottontail is also a possible vector of parasites and diseases that can harm native species and potentially humans. The species is resistant to myxomatosis while being a carrier of the disease, The Eastern cottontail resulted susceptible to the European Brown Hare Syndrome Virus (EBHSV) infection, which occasionally evolves to EBHS-like disease (Lavazza et al. 2015). The authors suggest that the Eastern cottontail could probably be considered a "spill over" or "dead end" host for EBHSV, but further evidence are needed. Experimental trials confirmed that cottontails are not susceptible to experimental infection with Rabbit Haemorrhagic Disease virus (RHDV) (Lavazza et al. 2015). Zanet et al. (2013) reported *Encephalitozoon cuniculi*, *Toxoplasma gondii* and *Neospora caninum* naturally infecting Eastern cottontails.Though found at low prevalence, the important role that these pathogens could play in both animal and human health should be considered. In the native range, Tiawsirisup et al. (2005) showed that cottontails could, under some circumstances, be a part of an enzootic cycle of West Nile virus (WNV) and serve as a source of WNV for anthrophilic mosquito species.
9. Describe any known socio-economic benefits of the organism in the risk assessment area.	Yes	In Italy the Eastern cottontail was introduced as a game species. The major attractions to hunters are its great productivity, its immunity to myxomatosis and also its quick zigzag running.

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?		The Eastern cottontail has the widest distribution of any species of *Sylvilagus* (Chapman et al. 1980), being present in the native range from northern South America to Southern Canada. In such a wide range the species is adapted to a variety of habitats and is considered a generalist species. General requirements are for open habitats close to high vegetation or shrub and hedgerows that provide shelters. Cottontail food habits vary greatly depending upon the geographic region and the availability of plant species (Chapman et al. 1982). Nearly every kind of grass, succulent herb, or flowering plant, can be consumed by cottontails (Sweetman 1944; Chapman et al. 1980). Most of Europe is within the latitudinal range of the specie in America and host similar habitats. The species is adapted to cultivated landscapes, typical of most European lowlands. The species has a high reproductive output. In the native range, breeding normally occurs from January to September, with yearly variation, starting later at elevation and in northern latitudes; in Texas it can breed year round (Chapman et al. 1980). Cottontails can reproduce when they are 3 months old and live an average of 15-18 months. Litter size is 3-7 with 5-7 litters per female; annual production could range from 6-10 to 35 young per adult female (Chapman et al. 1980).

		Research conducted in captivity and in enclosures in France highlighted the risks of crop damage and possible space and food competition with other lagomorphs (Arthur & Chapuis 1983; Chapuis et al. 1985). Cottontail herbivory damages shrubs and trees by eating all of the inner bark from around the trunk and chewing exposed roots. Damage is reported in orchards and poplar plantations (Chapman et al. 1982; Chapuis et al. 1985; Spagnesi 2002). Cottontails can also change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance. The cottontail is also a possible vector of parasites and diseases that can harm native species and potentially humans.
13. Does the organism occur outside effective containment in Europe?	Yes	In Italy
14. Is the organism widely distributed in Europe?	No	The Eastern cottontail is established in Italy in a large area in the northwestern part of the country that includes most of the Piedmont and the western part of Lombardy regions and with smaller populations located in other regions: Venetia, Friuli, Liguria, Emilia Romagna, Tuscany and Umbria. The distribution is mapped in Angelici & Spagnesi (2008) and Bertolino et al. (2011c).
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	In Italy the Eastern cottontail is a lowland species, typical of open herbaceous habitats near vegetation that provides cover, and of the edges between cultivations and natural vegetation. Its presence is favored by crops and meadows with high ecotones extension and wide hydrographic networks associated with riverside vegetation (Vidus-Rosin et al. 2009; Bertolino et al. 2011a,b,c, 2013) (open). This pattern of habitat use is similar to

		what reported in the agriculture-dominated portions of the species native range, selecting habitats with dense and permanent cover near crops, meadows and other herbaceous habitats used for feeding (Chapman et al. 1980; Swihart and Yahner 1982).
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 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	The Eastern cottontail has the widest distribution of any species of *Sylvilagus* (Chpaman et al. 1980), being present in the native range from northern South America to Southern Canada. In such a wide range the species is adapted to a variety of habitats and is considered a generalist species. General requirements are for open habitats close to high vegetation or shrub and hedgerows that provide shelters. Most of Europe is within the latitudinal range of the specie in America and host similar habitats. The species is adapted to cultivated landscapes, typical of most European lowlands. The native range of the eastern cottontail comprises warm temperate areas, moist and dry, with an extension in cool temperate zone in the North and tropical climate in the South. Therefore, Mediterranean, Continental and Atlantic biogeographic regions are areas were the species could potentially establish.

19. Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe?	Yes	The species could be maintained in zoological gardens and in private houses and parks
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	In Europe it was introduced in Italy, France, Belgium, Spain, Luxembourg and Switzerland (Long 2003; Trocchi & Riga 2005; DAISIE 2008; Scalera Riccardo pers. com.) for hunting purposes, but in recent times, wild populations have only survived in Italy (DAISIE 2008; see map in Bertolino et al. 2011c). The species has also been translocated in North America outside the native range in United States and Canada (Chapman et al. 2980; Long 2003).
21. Can the organism spread rapidly by natural means or by human assistance?	Yes	In Italy the first introduction of Eastern cottontails *was in 1966 (Mussa et al. 1996); since then the species has been introduced several times for hunting. In north-western Italy the Eastern cottontail spread in last decades to cover nearly all lowlands in Piedmont and in the western part of Lombardy, especially along rivers (Angelici & Spagnesi 2008; Bertolino et al. 2011c). Data on the temporal spread of the species are available for Alessandria Province (Piedmont). Herein, the species has dramatically expanded its range in the last fifteen years and population densities increased in many areas (Bertolino et al. 2011c). In the province of Alessandria (Piedmont region), for example, the range recorded at a municipality level increased linearly from 14 municipalities in 1995 to 83 in 2003, with a six-fold increase (Bertolino et al. 2011c). A quick spreading has also been recorded in Tuscany (Cerri J. pers. com.)* *Introductions* for hunting potentially create new propagules and could help the species to overcome ecological barriers and increase the spread rate.
22. Could the organism as such, or acting as a	Yes	Research conducted in captivity and in enclosures

vector, cause economic, environmental or social harm in Europe?		in France highlighted the risks of crop damage and possible space and food competition with other lagomorphs (Arthur & Chapuis 1983; Chapuis et al. 1985). Cottontail herbivory could damages shrubs and trees by eating all of the inner bark from around the trunk and chewing exposed roots. Damage is reported in orchards and poplar plantations (Chapman et al. 1982; Chapuis et al. 1985; Spagnesi 2002). In Italy the Eastern cottontail is linked to damage to cereals, vegetables, orchards and poplars; damage, however, have not been quantified. Cottontails can also change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance. The Eastern cottontail is also a possible vector of parasites and diseases that can harm native species and potentially humans. Cottontails resulted susceptible to the European Brown Hare Syndrome Virus (Lavazza et al. 2015). Zanet et al. (2013) reported *Encephalitozoon cuniculi*, *Toxoplasma gondii* and *Neospora caninum* naturally infecting Eastern cottontails. In the native range, Tiawsirisup et al. (2005) showed that cottontails could, under some circumstances, be a part of an enzootic cycle of West Nile virus (WNV) and serve as a source of WNV for anthrophilic mosquito species.

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)	Two	very high	The species is already present in the Risk Assessment area with viable and spreading populations in Italy. From Italy it could spread in other countries. Another pathway for new introductions is the release of animals for hunting.
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).	[Releases for hunting, spread from Italy]		The pathway for new introduction is the release of animals for hunting. The species has been already released for hunting in many countries (France, Spain, Belgium, Italy, Luxembourg and Switzerland outside EU28). Though in the past it has established viable populations only in Italy, habitats are suitable in most of Europe; therefore future introductions could be successful. In Italy the species is widely distributed in the north-western of the country. Herein, the species has dramatically expanded its range in the last fifteen years and population densities increased in many areas (Bertolino et al. 2011c). Therefore, an expansion to France and Switzerland in the medium term is possible (Chapuis et al. 2003)

Pathway name:	[Releases for hunting]		
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 has been already released for hunting in many countries (France, Spain, Belgium, Italy, Luxembourg and Switzerland outside EU28) and is established in Italy.
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.	likely	medium	The species has been introduced in some European countries for hunting in years 1950-1990. These introduction attempts have been in an effort to establish alternative game species for native rabbits and hares. Though new introductions are not reported, animals can be released again, especially as a replacement of hares and rabbits where they disappear or are at low densities.
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	high	The Eastern cottontail has the widest distribution of any species of *Sylvilagus* (Chapman et al. 1980), being present in the native range from northern South America to Southern Canada. In such a wide range the species is adapted to a variety of habitats and is considered a generalist species. General requirements are for open habitats close to high vegetation or shrub and hedgerows that provide shelters. Cottontail food habits vary greatly depending upon the geographic region and the availability of plant species (Chapman et al. 1982). Nearly every kind of grass, succulent herb, or flowering plant, could be consumed by the cottontail (Sweetman 1944; Chapman et al. 1980). Most of Europe is within the latitudinal range of the specie in America and host similar habitats. The species is adapted to cultivated landscapes, typical of most European lowlands. The species has a high reproductive output. In the native range breeding normally occurs from January to September, with yearly variations, starting later at

			elevation and in northern latitudes; in Texas it could breed year round (Chapman et al. 1980). Cottontails can reproduce when they are 3 months old and live an average of 15-18 months. Litter size is 4-7; annual production could range from 6-10 to 35 young per adult female.
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	very likely	high	The species is already present in Italy in large areas in the Central and Northern parts of the country.
End of pathway assessment, repeat as necessary.			
Pathway name:	[Spread from Italy]		
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)	accidental	very high	The Eastern cottontail is established in Italy in a large area in the northwestern part of the country that includes most of the Piedmont and the western part of Lombardy regions and with smaller populations located in other regions (Trocchi & Riga 2005; Bertolino et al. 2011c).
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.	likely	medium	In north-western Italy the Eastern cottontail spread in last decades to cover nearly all lowlands in Piedmont and in the western part of Lombardy, especially along rivers (Angelici & Spagnesi 2008; Bertolino et al. 2011c). Data on the spatial spread of the species are available for Alessandria Province (Piedmont). Herein, the species has dramatically expanded its range in the last fifteen years and population densities increased in many areas (Bertolino et al. 2011c). In the province of Alessandria (Piedmont region), for example, the range recorded at a municipality level increased linearly from 14 municipalities in 1995 to 83 in 2003, with a six-fold increase (Bertolino et al. 2011c). In the medium term, the species could colonize areas where the borders with France is at low altitude (southern Piedmont, western Liguria) and then surmountable by the species that will have the possibility to spread in this country (Chapuis et al. 2003). From Lombardy the species could enter the canton Ticino in Switzerland.

1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?	likely	high	The Eastern cottontail has the widest distribution of any species of *Sylvilagus* (Chpaman et al. 1980), being present in the native range from northern South America to Southern Canada. In such a wide range the cottontail is adapted to a variety of habitats and is considered a generalist species. General requirements are for open habitats close to high vegetation or shrub and hedgerows that provide shelters. Most of Europe is within the latitudinal range of the specie in America and host similar habitats. The species is adapted to cultivated landscapes, typical of most European lowlands. The species has a high reproductive output. In the native range breeding normally occurs from January to September, with yearly variations, starting later at elevation and in northern latitudes; in Texas it could breed year round (Chapman et al. 1980). Cottontails can reproduce when they are 3 months old and live an average of 15-18 months. Litter size is 4-7; annual production could range from 6-10 to 35 young per adult female.
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?	very likely	high	The species is already present in Italy in large areas in the Central and Northern parts of the country.
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).	Very likely	high	The species is already present in the Risk Assessment area with viable and spreading populations in Italy. In north-western Italy the Eastern cottontail has spread in last decades to cover nearly all lowlands in Piedmont and in the western part of Lombardy, especially along rivers (Angelici & Spagnesi 2008; Bertolino et al. 2011c). Data on the spatial spread of the species are available for Alessandria Province (Piedmont). Herein, the species has dramatically expanded its range in the last fifteen years and population densities increased in many areas (Bertolino et al. 2011c). In the province of

			Alessandria (Piedmont region), for example, the range recorded at a municipality level increased linearly from 14 municipalities in 1995 to 83 in 2003, with a six-fold increase (Bertolino et al. 2011c). From southern Piedmont and eastern Liguria the Eastern cottontail could spread to France along a border at low altitude, surmountable by the species. (Chapuis et al. 2003). From Lombardy the species could enter the canton Ticino in Switzerland. The species has been introduced in some European countries for hunting as an alternate game species for native rabbits and hares in years 1950-1990; it established viable populations in Italy. Though new introductions are not reported, animals can be released again, especially as a replacement of hares and rabbits where they disappear or are at low densities. According to Arthur (1984) the Eastern cottontail disappeared from France due to its sensitivity to predation or pathogens (pseudo-tuberculosis). These possible limiting factors should be better investigated, even considering that instead in Italy the species is spreading and seems not limited.

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**
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	widespread	high	The Eastern cottontail has the widest distribution of any species of *Sylvilagus* (Chpaman et al. 1980), being present in the native range from northern South America to Southern Canada. In such a wide range the species is adapted to a variety of habitats and is considered a generalist species. General requirements are for open habitats close to high vegetation or shrub and hedgerows that provide shelters. Most of Europe is within the latitudinal range of the specie in America and host similar habitats. The species is adapted to cultivated landscapes, typical of most European lowlands.
1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	likely	medium	The species has a high reproductive output that could help to survive intensive harvest. In the native range breeding normally occurs from January to September, with yearly variation, starting later at higher elevation and in northern latitudes; in Texas it can breed year round (Chapman et al. 1980). Cottontails can become reproductive when they are 3 months old and live an average of 15-18 months. Litter size is 3-7 with 5-7 litters per female; annual production could range from 6-10 to 35 young per adult female (Chapman et al. 1980). In Italy the species is controlled in some areas where the target is to increase the density of hares.

			However, despite hunting and control the species was spreading in the last decades. In the native range, fluctuations are due to climatic conditions and populations decline to change in the agricultural landscape, while it does not seem to be linked to predator pressure or hunting/control activities (Chapman et al. 1980; Mankin & Warner 1999).

PROBABILITY OF SPREAD			
Important notes: 5. 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.)	moderate	medium	The species is already established in Italy; however, quantitative studies on the spread are not available. In the province of Alessandria (Piedmont region), the range recorded at a municipality level increased linearly from 14 municipalities in 1995 to 83 in 2003, with a six-fold increase (Bertolino et al. 2011c). The species was introduced many times in Italy and other countries for hunting; these introductions potentially create new propagules and could help the species to overcome ecological barriers and increase the spread rate. In the medium term, the species could colonize areas where the borders with France is at low altitude (southern Piedmont, western Liguria) and then surmountable by cottontails that will have the possibility to spread in this country (Chapuis et al. 2003). From Lombardy the species could enter the canton Ticino in Switzerland.
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.)	moderate	medium	The species has been introduced in some European countries for hunting in years 1950-1990. These introduction attempts have been in an effort to establish alternate game species for native rabbits and hares. Though new introductions are not reported, animals can be released again, especially as a replacement of hares and rabbits where they disappear or are at low densities.
2.3. Within Europe, how difficult would it be to contain	difficult	medium	The species has a high reproductive output that could

the organism?			help to survive intensive harvest. In Italy the species is controlled in some areas where the target is to increase the density of hares. However, despite hunting and control the species was spreading in the last decades. In the native range, fluctuations are due to climatic conditions and populations decline to change in the agricultural landscape, while predator pressure or hunting/control activities seem to have little effect (Chapman et al. 1980; Mankin & Warner 1999).
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]	medium	The native range of the Eastern cottontail comprises warm temperate areas, moist and dry, with an extension in cool temperate zone in the North and tropical climate in the South. Therefore, Mediterranean, Continental and Atlantic biogeographic regions are areas were the species could potentially establish.
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	The Eastern cottontail is established in Italy in a large area in the northwestern part of the country that includes most of the Piedmont and the western part of Lombardy regions and with smaller populations located in other regions
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	A slightly expansion in Italy
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	According to the spread of the last two decades in other twenty years the species could potentially invade most of central and northern Italy. Therefore in this timeframe it would be possible to better evaluate its adaptability to Mediterranean and Continental habitats.

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?	10-20	medium	
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 native range of the Eastern cottontail comprises warm temperate areas, moist and dry, with climate that are present in Europe in the Mediterranean, Continental and Atlantic biogeographic regions.

PROBABILITY OF IMPACT

Important instructions:

6. 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.
7. 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).
8. 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?	minor	low	Research conducted in captivity and in enclosures in France highlighted the risks of crop damage (Arthur & Chapuis 1983; Chapuis et al. 1985). Cottontail herbivory could damages shrubs and trees by eating all of the inner bark from around the trunk and chewing exposed roots. Damage is reported in orchards and poplar plantations (Chapman et al. 1982; Chapuis et al. 1985; Spagnesi 2002). Cottontails can also change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance. In Italy the species is controlled in some areas where the target is to increase the density of hares. Till now damage and management costs were not quantified.
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		Damage is not quantified yet.

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 will spread from Italy to other countries or if it will be introduced elsewhere in Europe, the costs associated to the species will increase. However, since damage is not quantified in the present area of introduction it is impossible to estimate future costs for Europe.
2.13. How great are the economic costs associated with managing this organism currently in Europe (include any past costs in your response)?	moderate	medium	In Italy the species is controlled in some areas, mainly where the aim is to increase the density of hares, though a direct effect is not demonstrate. This cost, however, is not quantified yet.
2.14. How great are the economic costs associated with managing this organism likely to be in the future in Europe?	moderate	medium	In Italy the species is controlled in some areas, mainly where the aim is to increase the density of hares, though a direct effect is not demonstrate. If the species will spread from Italy to other countries or if it will be introduced elsewhere in Europe, the costs associated to the species management would increase. However, since management costs are not quantified yet in the present area of introduction it is impossible to estimate future costs for Europe.
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding Europe?	moderate	medium	In the native range, cottontail herbivory damages shrubs and trees by eating all of the inner bark from around the trunk and chewing exposed roots. Damage is reported in orchards and poplar plantations (Chapman et al. 1982). Cottontails can also change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance. In North America, the Eastern cottontail seems to compete with the native *S. transitionalis* in areas of introduction (Probert and Litvaitis 1996; Chapman, & Ceballos 1990).

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)?	minor	medium	Studies on the possible impacts of the Eastern cottontail on native species are limited. Research conducted in captivity and in enclosures in France highlighted the risks of possible space and food competition with other lagomorphs (Arthur & Chapuis 1983; Chapuis et al. 1985). Cottontails can change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance. A niche differentiation between the Eastern cottontail and the native European hare (*Lepus europaeus*) has been observed in northern Italy (Bertolino et al. 2011b; Vidus-Rosin et al. 2009, 2012; Bertolino et al. 2013), suggesting that habitat partitioning could avoid or reduce competition between these two species. Similar studies are not available for the European rabbit. Long-term demographic studies and/or experimental manipulations research are required to better evaluate the population interactions between the Eastern cottontails and native lagomorphs. The Eastern cottontail is also a possible vector of parasites and diseases that can harm native species. Cottontails resulted susceptible to European Brown Hare Syndrome Virus (Lavazza et al. 2015). Zanet et al. 2013 reported *Encephalitozoon cuniculi*, *Toxoplasma gondii* and *Neospora caninum* naturally infecting Eastern cottontails.
2.17. How important is the impact of the organism on biodiversity likely to be in the future in Europe?	moderate	medium	Information on the impacts on native species is limited because of the few available studies (see point 2.16). Therefore, at the moment any inference about the magnitude of possible future negative effects on European biodiversity has a low to medium confidence.

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)?	minor	medium	Cottontails can change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance.
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	medium	Cottontails can change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance. It is however, difficult to predict the real impact in Europe, therefore the confidence of this evaluation is only medium.
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?	minor	medium	According to the present knowledge, there are no indications of possible effects on species of European concern. A niche differentiation between the Eastern cottontail and the native European hare has been observed in northern Italy (Bertolino et al. 2011b; Vidus-Rosin et al. 2009, 2012; Bertolino et al. 2013), suggesting that habitat partitioning could avoid or reduce competition between the two species. Similar studies are not available for the European rabbit. Long-term demographic studies and/or experimental manipulations research are required to better evaluate the population interactions between the Eastern cottontails and native lagomorphs. The cottontail is a possible vector of parasites and diseases that can harm native species; however this possible impact should be further investigated (Zanet et al. 2013; Lavazza et al. 2015).
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?	minor	low	The data available do not show possible impacts; however, studies are scanty and the possible role as vector of parasites and diseases and the effects of cottontails by over-grazing in areas with high densities should be better evaluated. Considering this situation, it is difficult to estimate future impacts.

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	medium	The Eastern cottontail is a possible vector of parasites and diseases that can harm native species and potentially humans. Zanet et al. 2013 reported *Encephalitozoon cuniculi*, *Toxoplasma gondii* and *Neospora caninum* naturally infecting Eastern cottontails; though found at low prevalence, the important role that these pathogens could play in both animal and human health should be considered. In the native range, Tiawsirisup et al. (2005) showed that cottontails could, under some circumstances, be a part of an enzootic cycle of West Nile virus (WNV) and serve as a source of WNV for anthrophilic mosquito species.
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)?	moderate	medium	The cottontail is a possible vector of parasites and diseases that can harm native species and potentially humans. The species is resistant to myxomatosis while being a carrier of the disease, The Eastern cottontail resulted susceptible to European Brown Hare Syndrome Virus (EBHSV) infection, which occasionally evolves to EBHS-like disease (Lavazza et al. 2015). The authors suggest that the Eastern cottontail could probably be considered a "spill over" or "dead end" host for EBHSV, but further evidence are needed. Experimental trials confirmed that cottontails are not susceptible to experimental infection with Rabbit Haemorrhagic Disease virus (RHDV) (Lavazza et al. 2015). Zanet et al. 2013 reported *Encephalitozoon cuniculi*, *Toxoplasma gondii* and *Neospora caninum* naturally infecting Eastern cottontails. Though found at low prevalences, the

			important role that these pathogens could play in both animal and human health should be considered. In the native range, Tiawsirisup et al. (2005) showed that cottontails could, under some circumstances, be a part of an enzootic cycle of West Nile virus (WNV) and serve as a source of WNV for anthrophilic mosquito species.
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?	moderate	medium	A range of potential predators exist in Europe, these include raptors and carnivorous mammals. These predators have not prevented the establishment of the species in Italy, nor the spread of the animals especially in the northern part of the country. In the native range the species is adapted to many potential predators and parasites. Cottontails are a stable food item for most of the carnivorous mammals found within the cottontail's range (Chapman et al. 1980). This high predator pressure is, however, compensated by the high reproductive rate. It is therefore likely that predators and pathogens will not reduce the impacts of 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).	[Presently Italy]	medium	Environmental and economic impacts, though not quantified are presently occurring in Italy. In the future they could occur in areas of introductions or populations expansion, particularly southeastern France and Canton Ticino.

RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	very likely	very high	The species is already present in the Risk Assessment area with viable and spreading populations in Italy. From Italy it could spread in other countries. Another pathway for new introductions is the release of animals for hunting. The species has been already released for hunting in many countries (France, Spain, Belgium, Italy, Luxembourg and Switzerland outside EU28). Though in the past it has established viable population only in Italy, habitats are suitable in most of Europe; therefore future introductions could be successful. In Italy the species is widely distributed in the north-western of the country. Herein, the species has dramatically expanded its range in the last fifteen years and population densities increased in many areas (Bertolino et al. 2011c). Therefore, an expansion to France and Switzerland in the medium term is possible (Chapuis et al. 2003).
Summarise Establishment	very likely	very high	The Eastern cottontail is already established in Italy in a large area in the northwestern part of the country that includes most of the Piedmont and the western part of Lombardy regions and with smaller populations located in other regions (Trocchi & Riga 2005; Bertolino et al. 2011c). The Eastern cottontail has the widest distribution of any species of *Sylvilagus* (Chpaman et al. 1980), being present in the native range from northern South America to Southern Canada. In such a wide range the species is adapted to a variety of habitats and is considered a generalist species. General requirements

			are for open habitats close to high vegetation or shrub and hedgerows that provide shelters. Cottontail food habits vary greatly depending upon the geographic region and the availability of species (Chapman et al. 1982). Nearly every kind of grass, succulent herb, or flowering plant, could be consumed by the cottontail (Sweetman 1944; Chapman et al. 1980). Most of Europe is within the latitudinal range of the specie in America and host similar habitats. The species is adapted to cultivated landscapes, typical of most European lowlands. The possibility to establish further viable populations are increased by the high reproductive rate. The native range of the Eastern cottontail comprises warm temperate areas, moist and dry, with an extension in cool temperate zone in the North and tropical climate in the South. Therefore, Mediterranean, Continental and Atlantic biogeographic regions are areas were the species could potentially establish in Europe. According to Arthur (1984) the Eastern cottontail disappeared from France due to its sensitivity to predation or pathogens (pseudo-tuberculosis). These possible limiting factors should, however, be better investigated, even considering that instead in Italy the species is spreading and seems not limited.
Summarise Spread	moderately	medium	The species is already established in Italy; however, quantitative studies on the spread are not available. In the province of Alessandria (Piedmont region), the range recorded at a municipality level increased linearly from 14 municipalities in 1995 to 83 in 2003, with a six-fold increase (Bertolino et al. 2011c). In the medium term, the species could colonize areas where the borders with France is at low altitude (southern Piedmont, western Liguria) and then surmountable by cottontails that will have the possibility to spread in this country

			(Chapuis et al. 2003). From Lombardy the species could enter the canton Ticino in Switzerland. The species has been introduced in some European countries for hunting in years 1950-1990. These introduction attempts have been in an effort to establish alternate game species for native rabbits and hares. Though new introductions are not reported, animals can be released again, especially as a replacement of hares and rabbits where they disappear or are at low densities. These introductions potentially create new propagules and could help the species to overcome ecological barriers and increase the spread rate.
Summarise Impact	moderate	medium	Research conducted in captivity and in enclosures in France highlighted the risks of crop damage and possible space and food competition with other lagomorphs (Arthur & Chapuis 1983; Chapuis et al. 1985). In North America, the Eastern cottontail seems to compete with the native *S. transitionalis* in areas of introduction (Probert and Litvaitis 1996; Chapman, & Ceballos 1990). A niche differentiation between the Eastern cottontail and the native European hare has been observed in northern Italy (Bertolino et al. 2011b; Vidus-Rosin et al. 2009, 2012; Bertolino et al. 2013), suggesting that habitat partitioning could avoid or reduce competition between the two species. Similar studies are not available for the European rabbit. Cottontail herbivory damages shrubs and trees by eating all of the inner bark from around the trunk and chewing exposed roots. Damage are reported in orchards and poplar plantations (Chapman et al. 1982; Chapuis et al. 1985; Spagnesi 2002). Cottontails can also change the composition of plant communities by over-grazing their preferred species such as plants with higher nutritional content, thus allowing less palatable plants to increase in relative abundance.

			The cottontail is also a possible vector of parasites and diseases that can harm native species and potentially humans.
Conclusion of the risk assessment	moderate	medium	The species is already present in the Risk Assessment area with viable and spreading populations in Italy. From Italy it could spread in other countries. Another pathway for introductions is the release of animals for hunting. The species has been already released for hunting in other European countries. Though in the past it has established viable population only in Italy, habitats are suitable in most of Europe; therefore future introductions could be successful. In case of new introductions in the Mediterranean, Continental and Atlantic biogeographic regions, the likelihood of establishment is medium to high and the spread could be from slowly to moderate, depending on the habitat. Possible impacts regard the competition with other lagomorphs, though first results show a habitat partitioning with the European hare. Damage to crop and natural vegetation could be important in areas of high densities, overgrazing by cottontails can also change the composition of plant communities. The cottontail is also a possible vector of parasites and diseases that can harm native species and potentially humans.

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]	medium	The Eastern cottontail has the widest distribution of any species of *Sylvilagus* (Chpaman et al. 1980), being present in the native range from northern South America to Southern Canada. In such a wide range the species is adapted to a variety of climate and is considered a generalist species. The onset of reproduction is positively related to latitude and elevation, with reproduction occurring later at higher latitudes (Conaway et al. 1974). Therefore, climate change would anticipate reproduction at northern latitudes, giving females more time for breeding and probably increasing their reproductive success.
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 but relations with native species should be investigated]	high	Confidence in the risk assessment is medium too high for establishment and spread. Information on damage and impact to biodiversity is still limited and further research is needed to better clarify the role of the species in European ecosystems. Long-term demographic studies and/or experimental manipulations are required to better evaluate the population interactions between the Eastern cottontails and the native lagomorphs. Further studies are also necessary to clarify the possible role of the species as vector of parasites and diseases that can harm native species and potentially humans and if pathogens and predators could act as limiting factors for cottontails.

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