EU NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

Name of organism: ***Nyctereutes procyonoides*** **(Gray, 1834)**
Author: Deputy Direction of Nature
Risk Assessment Area: Europe

Draft: 07/05/2015

Peer reviewed by: Bertolino Sandro, University of Turin, Italy
Date of finalisation: 29/07/2016

EU CHAPPEAU	
QUESTION	**RESPONSE**
1. In how many EU member states has this species been recorded? List them.	Austria, Bulgaria, Denmark, Estonia, Finland, Germany, Italy, Hungary, Latvia, Lithuania, Netherlands, Poland, Romania, Slovakia, Sweden, France; Czech Republic; Belgium; Slovenia. During the last decade, a further range expansion of racoon dog into Mediterranean areas has been shown by road-killed individuals: 2008 in Southern Spain (ANSE, 2010).
2. In how many EU member states has this species currently established populations? List them.	Established in the Bulgaria, Czech Republic, Estonia, Finland, Germany, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia (Baiwy et al. 2013), Sweden, Denmark (Dahl et al. 2013), France (Léger, 2008). The species is recorded also in Austria, Italy and the Netherlands, though sometime with few records (Kauhala and Winter 2006)
3. In how many EU member states has this species shown signs of invasiveness? List them.	In accordance to Kowalczyk (2014), in some areas (e.g. in Finland, Baltic countries), *N. procyonoides* is the most common carnivore. It is widespread and common in Finland, Poland, Latvia, Lithuania, Estonia and Germany. The species is rare, but with an increase in numbers in Sweden and Denmark. It occurs also in Czech Republic, Slovakia, Hungary, Bulgaria and Romania. It is sporadically seen in Austria, France, Netherlands, (first breeding observed in 2005, R. Andersen, pers. com.(In NOBANIS), Slovenia (MitchellJones et al. 1999, Kauhala and Saeki 2004a). Some raccoon dogs have also been seen in the eastern Alps in Italy (P. Genovesi, in press).
4. In which EU Biogeographic areas could this species establish?	According to the range in the native area and the present distribution in Europe the specie could establish viable population in the Continental, Atlantic, Boreal and Pannonian biogeographich areas. In the native range *N. procyonoides* is present also in warm areas with dry summer, therefore an establishment in Mediterranean habitats could not be excluded; in fact the species is present in some areas in Macedonia and Spain.
5. In how many EU Member States could this species establish in the	Probably all or most EU-countries; Austria, Bulgaria, Croatia, Cyprus, Greece,

future [given current climate] (including those where it is already established)? List them.	Ireland, Luxembourg, Malta, Portugal, Great Britain, Denmark, Estonia, Finland, Germany, Italy, Hungary, Latvia, Lithuania, Netherlands, Poland, Romania, Slovakia, Sweden, France; Czech Republic; Belgium, Slovenia, Spain, UK.
6. In how many EU member states could this species become invasive in the future [given current climate] (where it is not already established)?	In most of the European countries

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?	*Nyctereutes procyonoides* (Gray, 1834)	Yes, this species can be adequately distinguished from other entities of the same rank in Europe. (In Japan, *Nyctereutes viverrinus* is a similar species.)
2. If not a single taxonomic entity, can it be redefined? (if necessary use the response box to re-define the organism and carry on)	NA	
3. Does a relevant earlier risk assessment exist? (give details of any previous risk assessment)	No	A Risk Assessment has been conducted in Belgium and The Netherlands and the result was that the species has high potential of establishment and dispersal in those countries. In Belgium, according to ISEIA protocol, the raccoon dog receives a score of 9 and falls in category B1, representing a 'moderate environmental risk'. The risk-assessment produced in Netherland (Mulder 2011) report the ISEIA score (B1-9) but applied also and Australian risk assessment procedure. According to this procedure, the raccoon dog in Europe received the following values for the three risk scores: 0 (not dangerous), 13 (extreme establishment risk) and 14 (moderate pest risk). Combining these scores according to the rules of the model, results in threat category 'extreme' for the raccoon dog. This result differs from the outcome of the ISEIA protocol. The

		reason behind this discrepancy is, that the Australian model more strongly focuses on the risk of an exotic species arriving in the country and establishing a population. The raccoon dog scores 13 of the 14 possible points on this aspect: it is certain to arrive in the Netherlands and to establish a population here. The ISEIA protocol is originally designed only for the species already established in Europe.
4. If there is an earlier risk assessment is it still entirely valid, or only partly valid?	No	They only consider single countries.
5. Where is the organism native?	China; Japan; Korea, Democratic People's Republic of; Korea, Republic of; Mongolia; Russian Federation (Amur, Central European Russia - Introduced, Chita, East European Russia) (Kauhala & Saeki 2008).	Japanese raccoon dogs should be classified as separate species: *Nyctereutes viverrinus* (Kim et al. 2015).
6. What is the global distribution of the organism (excluding Europe)?	**Native**: China; (Japan); Korea, Democratic People's Republic of Korea, Republic of Mongolia; Viet Nam, Russian Federation (Amur ja Ussuri regions), **Introduced** (subspecies *N. p. ussuriensis*): Asia: Transcaucasia, North Caucasus, Abkhazia, Astrakhan, Southern Ossetia, Karatalinia, Kazakhstan, Kirgizia, Chita, Khabarovsk European Russia: Leningrad, Novgorod, Kalinin and Ryazan provinces, Pskov, Kola Peninsula, Karelian Isthmus, Archangel. Other European countries (excluding EU):Belarus;; Moldova; Norway; Switzerland; Ukraine	

	Present - origin uncertain: Uzbekistan (Kauhala & Saeki 2008).	
7. What is the distribution of the organism in Europe?	Austria, Belarus, Belgium, Bulgaria, Czech, Denmark, Estonia, Finland, France, Germany, Italy, Hungary, Latvia, Lithuania, Moldova, Netherlands, Norway, Poland, Western Russia, Romania, Slovakia, Sweden, Switzerland and Ukraine	The raccoon dog quickly colonized new areas after being introduced to the European part of the former Soviet Union. Today it is widespread in Northern and Eastern Europe and is still spreading in Central Europe. Features behind its success include its adaptability, high reproductive potential, omnivory, hibernation in northern areas, multiple introductions with > 9000 individuals from different localities, and tendency to wander enabling gene flow between populations (Kauhala & Kowalczyk 2011).
8. Is the organism known to be invasive (i.e. to threaten organisms, habitats or ecosystems) anywhere in the world?	Yes. It is vector of diseases and parasites.	It was listed in the top 100 most damaging invasive species by the DAISIE project (http://www.europe-aliens.org/speciesTheWorst.do). Raccoon dogs have been reported to cause severe damage to waterfowl colonies (Kauhala 1996a; Kull et al 2001; Kowalczyk 2014). Raccoon dogs may become a threat to bird and frog populations, particularly on islands (Kauhala 1996a). However, some predator removal experiment show no effect on waterfowl or contrasting results (Kauhala, 2004; Väänänen et al., 2007) Birds eaten by raccoon dogs are mainly passerines (Kauhala, 2009; Sutor et al., 2010). They are more important for raccoon dogs when voles are scarce than during vole peak population times (Ivanova, 1962; Judin, 1977;

		Kobylińska, 1996).” Kauhala & Kowalczyk (2011 and references therein). Both adult frogs and tadpoles are easy prey for raccoon dogs and this may cause a decline in frog populations, especially on islands and in other fragmented or isolated areas (Kauhala and Auniola, 2001; Sutor et al., 2010). Frogs were scarce in the diet of raccoon dogs in the outer archipelago in southern Finland, although they occurred commonly in the diet on the mainland (Kauhala and Auniola, 2001). The raccoon dog is a very important vector of rabies, sarcoptic mange, trichinellosis and *Echinococcus multilocularis*. The Raccoon dog is one of the main vector of rabies in Europe. In the 1990s in Poland, Lithuania, Latvia and Estonia, from 7 to 16% of all rabies cases were found in raccoon dogs. In Estonia, >50% of wildlife rabies cases were found in raccoon dogs in 2004. In 1999-2004 in Poland over 700 raccoon dogs (i.e. 8 % of all cases) with rabies were recorded. During rabies epizootic in Finland in late 1980s, 77% of the cases identified were in raccoon dogs (Westerling 1991). This is no doubt the most severe consequence of the colonization of this alien species in Europe. Despite a relatively short period since its invasion into Denmark, raccoon dogs examined harbored a broad range of parasites, of which several are of zoonotic importance. The minute *P. summa* detected in the present study have never before been found in raccoon dogs in Europe or in foxes in Denmark

		(Nafi Solaiman Al-Sabi et al. 2013) *Echinococcus multilocularis* is the infective agent of alveolar echinococcosis, which is an emerging infectious disease with a high mortality rate in humans. The prevalence found in raccoon dogs are usually lower than that of red fox in the same area, however, considering that the raccoon dog is becoming increasingly widespread and is already abundant in several countries in Europe, the role of the species must be taken seriosly when assessing the *E. multilocularis* related risks to public health (Laurimaa et al. 2015, Schwarz et al 2011). Sutor et al (2014) hypothesize that the raccoon dog may, in addition to the red fox as the main definitive host, increase the risk for humans to become exposed to *E. multilocularis*. Biological characteristics of the raccoon dog make this carnivore an ideal host and vector for a variety of pathogens (Sutor et al. 2014).
9. Describe any known socio-economic benefits of the organism in the risk assessment area.		The raccoon dog was imported for fur-farming. While the species is still commonly farmed for fur in Finland, raccoon dogs are no longer farmed in Sweden (Kauhala & Saeki, 2008) or Hungary, where the last fur farm was closed in 1995 (Kauhala & Saeki, 2008). **According to Fur Europe :** ***Nyctereutes procyonoides*** *are farmed in Finland and Poland. The majority of the farms are in Finland.* **Key figures (2015):** Farms in Finland: 94 farms; Farms in Poland: 34 farms. Number of animals: 24.328 (males 8.522, cubs 147.696). Sales value

		(Saga Furs): 14.155.617 Euros Employment in connection to finnraccoon farms: It is difficult to give an exact number of employment as it is not only the farmer and his/her employees that are involved in the farming process. In addition, related industries such as feed kitchens, production of equipment for the farms, auction employees when the skins are sold etc. that should be accounted when talking about the amount. The numbers above only include the farmers that are members of the national breeders' associations, but only a small number of farms are not registered with the breeders' associations. The production cost for the farmer is around 80 €/skin (11,2 mill. € annually) - the feed cost/skin is somewhat over 40 €, i.e. a bit more than half of the total production cost. (in average 125 kg feed/skin produced á 350 €/ton of feed). The turnover for the feed industry is about 5,6 mill. € annually. - About 100.000 animals are vaccinated against parvovirus enteritis yearly. The turnover for vaccines is approximately 40.000 € in total annually. - The pelting of Finn raccoon is performed both on the farms and in pelting centers. The cost for pelting the production of Finn raccoon pelts is about 1,25 mill. € annually. (140 000 animals á 9 €). - The labor costs on the farm per Finn raccoon breeding female is 2,5 h * 17 €/h =42,50 €. Salary for the farmer is included. The average auction price for the Finn raccoon

		skins has been around 120 € during the recent years. The sales in total has brought in approximately 16,8 mill. € annually.

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	high	The raccoon dog may expand in Europe following two main pathways: the natural spread from areas where the species is already established poses the most significant risk of expansion. In the period from 1935 to 1984 the raccoon dog colonised 1.4 million km2 of Europe by secondary expansion (Nowak 1984). The raccoon dog is still sold and moved all over Europe therefore there is a risk of escape or release from captivity. The raccoon dog is one species that was sold and moved all over Europe. Nowadays the pet trade in Europe is more occasional, though still present. It is unknown and probably unlikely however, that raccoon dogs are imported from outside Europe. Most likely the trade takes place within Europe.
1.2. List relevant pathways through which the organism could enter. Where possible give detail about the specific	[escape or release from captivity		In eastern parts of its invaded range there were several intentional introductions. From these starting points the

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).	/Spread]		raccoon dog migrated westwards into new areas. In some regions animals escaped from fur farms (Kauhala and Winter, 2006). Nowadays natural spread from areas where the species is already established poses the most significant risk of expansion. Also transport as pets is possible.
Pathway name:	[inset pathway name here]		
1.3. Is entry along this pathway intentional (e.g. the organism is imported for trade) or accidental (the organism is a contaminant of imported goods)? (If intentional, only answer questions 1.4, 1.9, 1.10, 1.11)			
1.4. How likely is it that large numbers of the organism will travel along this pathway from the point(s) of origin over the course of one year? Subnote: In your comment discuss how likely the organism is to get onto the pathway in the first place.			
1.5. How likely is the organism to survive during passage along the pathway (excluding management practices that would kill the organism)? Subnote: In your comment consider whether the organism could multiply along the pathway.			
1.6. How likely is the organism to survive existing management practices during passage along the pathway?			
1.7. How likely is the organism to enter Europe undetected?			
1.8. How likely is the organism to arrive during the			

months of the year most appropriate for establishment?			
1.9. How likely is the organism to be able to transfer from the pathway to a suitable habitat or host?			
1.10. Estimate the overall likelihood of entry into Europe based on this pathway?			
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).			

PROBABILITY OF ESTABLISHMENT

Important instructions:

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

QUESTION	RESPONSE	CONFIDENCE	COMMENT
1.12. How likely is it that the organism will be able to establish in Europe based on the similarity between climatic conditions in Europe and the organism's current distribution?			
1.13. How likely is it that the organism will be able to establish in Europe based on the similarity between other abiotic conditions in Europe and the organism's current distribution?			
1.14. How likely is it that the organism will become established in protected conditions (in which the environment is artificially maintained, such as wildlife parks, glasshouses, aquaculture facilities, terraria, zoological gardens) in Europe? Subnote: gardens are not considered protected conditions			
1.15. How widespread are habitats or species necessary for the survival, development and multiplication of the organism in Europe?	widespread	high	Based on Kauhala and Winter (2006): Native (EUNIS code) B: Coastal habitats, G: Woodland and forest habitats and other wooded land, I: Regularly or recently cultivated agricultural, horticultural and domestic habitats, X8: Rural mosaics, consisting of woods, hedges, pastures and crops, J: Constructed, industrial and other artificial habitats.

			Habitat occupied in invaded range (EUNIS code) C3: Littoral zone of inland surface waterbodies, D: Mire, bog and fen habitats; E: Grassland and tall forb habitats, F4: Temperate shrub heathland, G: Woodland and forest habitats and other wooded land, I: Regularly or recently cultivated agricultural, horticultural and domestic habitats, X8: Rural mosaics, consisting of woods, hedges, pastures and crops. Raccoon dogs often live near water and prefer moist forests with abundant undergrowth. The habitat is dependent on food availability, in autumn especially fruits and berries. Most of Europe can be classified as suitable for the species, where the raccoon dog will survive, reproduce and expand (Kauhala & Kowalczyk, 2011). Only limited are are unsuitable for the specie (e.g. mountain range in the Nordic countries, Alpine habitats), but such habitats will however be utilised as corridors for spread (Melis et al. 2007). In suitable habitats the raccoon dog will reach densities far higher than the natural predator community of similar size (red fox, badger) combined (Kauhala 2006). In habitat highly suitable (rich wetlands) the raccoon dog density can become extremely high; up to 200 raccoon dogs were killed annually per 10 Km^2 in a Finnish experiment 2002-2005 (Väänänen et al. 2007). Northern range is limited by annual mean temperature below 0°C, a snow cover of 800mm, the duration of the snow cover of 175 days and length of growing season of 135 days (Lavrov 1971, Helle & Kauhala 1991). Until the late XXth

			century the species range to the north was up to Oulu in northern Finland. Only a few single animals were sporadically found in northern Sweden and Norway (Melis et al. 2007). The climate has however changed the last 20-30 years (SMHI). In Northern Sweden the mean annual temperature have become several degrees higher and now exceeds the temperature limit for population establishment. In 2006 the first reproduction was found in Northern Sweden. Raccoon dogs, also reproductions, are today found also in the far north of Sweden, Norway and Finland (Dahl et al. 2013). The further south in Europe we go, the more optimal the habitat get for the raccoon dog which mean high reproduction and extremely high population densities, especially in wetland areas.
1.16. If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in Europe?			
1.17. How likely is it that establishment will occur despite competition from existing species in Europe?			
1.18. How likely is it that establishment will occur despite predators, parasites or pathogens already present in Europe?			
1.19. How likely is the organism to establish despite existing management practices in Europe?			
1.20. How likely are management practices in Europe to facilitate establishment?			

1.21. How likely is it that biological properties of the organism would allow it to survive eradication campaigns in Europe?	likely	medium	The raccoon dog is highly adaptable to habitat, climate and food resources and expands their range when possible. Features behind its success include high reproductive potential (mean 8-10, up to 16 pups), omnivory, hibernation in northern areas, and tendency to wander enabling gene flow between populations. (Kauhala & Kowalczyk, 2011). The diet of raccoon dogs varies between areas and seasons, according to the availability of different food sources. The raccoon dog produces a relatively large litter, larger than expected for a medium-sized carnivore species (Kauhala, 1996b). It usually consists of 6 to 9 pups, with a recorded maximum of 16 pups. In the original range average litter size varies from 7.2 - 9.8 pups (Judin, 1977, cited by Ansorge & Stiebling, 2001). Raccoon dogs reach sexual maturity at the age of 10 months (Helle & Kauhala 1995, Kowalczyk et al. 2009). Sixty-six percent of one-year old individuals give birth, and the proportion of reproducing females is higher in older females (78% at 2 years, 88% at 3 years, 84% at 4 years and 93% thereafter). Although productivity of 1-year-old females is lowest (5.7 pups/female), they produce a large proportion of pups in the population due to their high numbers. Racoon dogs also have a high tendency to wander far. The mean dispersal distances of juvenile raccoon dogs in southern Finland were estimated to 14-19 km but some individuals may wander as far as 50-70 km, even 145 km, from the marking place (Kauhala et al. 1993b, Kauhala & Helle 1994, Kauhala et al. 2006).

			Their combination of favourable circumstances, efficient breeding system and flexible behaviour make very difficult eradication campaign. The species may adapt to eradication campaigns to some extent by density dependent fecundity if the resources increases due to lower population density, and by increasing dispersal rate and distance when the population density get smaller (Kowalczyk 2014). A LIFE09 NAT/SE/000344 project (Management of the invasive Raccoon Dog (*Nyctereutes procyonoides*) in the north-European countries) shown that it is possible to reduce the population and keep it low in large areas, useful for example for vulnerable wetlands. (Dahl et al 2010, 2015). The raccoon dog is highly monogamous (Kauhala et al. 1998) which makes the use of sterilised Judas animals very effective to find animals (Dahl et al 2010, 2013). Its omnivorous food choice makes the raccoon dog very easy to find by baiting and to capture with traps and dogs. In Sweden and northern Finland the raccoon dog population is showing obvious decreases in population size due to the management and the Swedish population is today kept enclosed at a low level in Northern Sweden.
1.22. How likely are the biological characteristics of the organism to facilitate its establishment?			

1.23. How likely is the capacity to spread of the organism to facilitate its establishment?			
1.24. How likely is the adaptability of the organism to facilitate its establishment?			
1.25. How likely is it that the organism could establish despite low genetic diversity in the founder population?			
1.26. Based on the history of invasion by this organism elsewhere in the world, how likely is to establish in Europe? (If possible, specify the instances in the comments box.)			
1.27. If the organism does not establish, then how likely is it that transient populations will continue to occur? Subnote: Red-eared Terrapin, a species which cannot re-produce in GB but is established because of continual release, is an example of a transient species.			
1.28. Estimate the overall likelihood of establishment (mention any key issues in the comment box).			

PROBABILITY OF SPREAD

Important notes:

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

QUESTION	RESPONSE	CONFIDENCE	COMMENT
2.1. How important is the expected spread of this organism in Europe by natural means? (Please list and comment on the mechanisms for natural spread.)	major	high	The raccoon dog is one of the most successful alien carnivores in Europe (Kauhala & Kowalczyk, 2011). It has spread rapidly into many European countries after being introduced by Russians during the first half of the 20th century (e.g., Lavrov, 1971; Lever, 1985; Helle and Kauhala, 1991). There are trends of range expansion towards South and Western Europe. It is expected that the raccoon dog will expand its range in the already invaded countries very quickly (Kauhala and Winter, 2006). Their combination of favourable circumstances, efficient breeding system and flexible behaviour is very likely to have supported the expansion of the species in Central Europe and will most probably continue to do so in the future (Zoller and Drygala, 2013). The northern limit of the raccoon dog's distribution is determined by climate. It can live in areas where the mean annual temperature is above 0°C, the thickness of snow cover is < 80 cm, the snow cover lasts < 175 days and the length of the growing season for plants is at least 135 days (Lavrov, 1971). Today the northern limit of its permanent distribution lies at the Arctic Circle (Helle and Kauhala, 1991). Raccoon dogs will possibly widen their distribution area northwards due to climate change. Increased spring precipitation in

			the form of snow at higher latitudes may, however, compensate for the effect of global warming (Melis et al., 2010). Further range expansion towards Southern and Western Europe has already begun (Kauhala & Kowalczyk, 2011).
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	If kept in captivity (private detention by amateurs, zoo or fur farm), accidental escape will only occur due to owner negligence, which has however, already been reported to occur in neighbouring countries (Stier 2006). Fur farms are still active in Finland, but the security at these sites is considered good, although nothing is 100%. In this case the largest threat probably comes from people trying to release the animals out of ethical aspects. Passive transport by humans could happen (http://www.expressen.se/gt/tvattbjornar-hittade-i-goteborgs-hamn/), but is considered unlikely. This way of spread is probably less likely, or less common, compared to the other possibilities.
2.3. Within Europe, how difficult would it be to contain the organism?	difficult	high	*N. procyonoides* is difficult to eradicate when it has colonised an area. It has a tendency to increase its litter size (up to 16; Helle and Kauhala, 1995) when the population is under heavy hunting pressure. Furthermore, if the hunting pressure is high in one area and the population temporarily declines, juveniles will wander into the area from adjacent areas and the population will recover within a few months. Difficult but not impossible. Especially for countries where it is still absent or exist at low densities it is possible to decrease and contain the population. In Sweden, Finland, Denmark and Norway the raccoon

			dog is since 2008 contained in Northern Sweden and on Jylland (Dahl et al. 2013, Svenska Jägareförbundet 2015). On the Finnish side of the Torne river the population is kept at very low densities to ease the work in Sweden (Alhainen, 2015). This Nordic area is almost the size of the rest of the EU countries. It will however be a greater challenge in central Europe since most countries have land locked borders to several other countries which is not the case in the Nordic countries. To succeed it is important that the countries work together in a common management framework such as in Sweden, Finland, Denmark and Norway. These countries demonstrate methods, tools and a successful example how to manage the raccoon dog in the LIFE09 NAT/SE/000344. The project have shown that it is possible to reduce the population and keep it low in large areas, useful for example for vulnerable wetlands. The project developed population models which show that without its efforts, raccoon dog population would be significantly larger than at present.
2.4. Based on the answers to questions on the potential for establishment and spread in Europe, define the area endangered by the organism.	[Most of Europe]	high	All of Europe apart from the high alps in central Europe and Nordic alpine mountains.
2.5. What proportion (%) of the area/habitat suitable for establishment (i.e. those parts of Europe were the species could establish), if any, has already been colonised by the organism?	10-33	medium	Considering the biogeographic areas suitable for the species (Continental, Atlantic, Boreal and Pannonian and possibly Mediterranean) and the present distribution (see map in DAISIE) about 30-40 of the area suitable for establishment has already been colonised by the raccoon dog.
2.6. What proportion (%) of the area/habitat suitable for establishment, if any, do you expect to have been invaded	10-33	high	Baiwy et al. (2013) indicates in the Risk Analysis done for Belgium that the raccoon dog can easily

by the organism five years from now (including any current presence)?			spread over long distances and has the capacity to colonize the Belgian territory in one decade only. It has a very high linear expansion rate, contained between 20 and 40 km per year. The species is spreading in many countries, but considering the extend of the area already occupied, in five year the increase in range would be limited.
2.7. What other timeframe (in years) would be appropriate to estimate any significant further spread of the organism in Europe? (Please comment on why this timeframe is chosen.)	20	medium	The species is spreading in many countries and in two decades it can be assumed that localized populations could cover large areas. In northern Sweden models of the invading population show that the population would increase from 100 animals to over 10000 animals in 15 years time (Dahl et al. 2013).
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?	33-67	medium	The species is spreading in many countries and in two decades it can be assumed that localized populations could cover large areas.
2.9. Estimate the overall potential for future spread for this organism in Europe (using the comment box to indicate any key issues).	rapidly	medium	The raccoon dog quickly colonized new areas after being introduced to the European part of the former Soviet Union. Today it is widespread in Northern and Eastern Europe and is still spreading in Central Europe. Features behind its success include its adaptability, high reproductive potential, omnivory, hibernation in northern areas, multiple introductions with > 9000 individuals from different localities, and tendency to wander enabling gene flow between populations (Kauhala & Kowalczyk, 2011). There are trends of further range expansion towards South and Western Europe. It is expected that the raccoon dog will expand its range in the already invaded countries very quickly (Kauhala and Winter,

			2006). From the first observation in the eastern part of the country in 1955 it took only 15 years for the raccoon dog to spread and establish all over Poland (Kauhala & Kowalczyk, 2011). Their combination of favourable circumstances, efficient breeding system and flexible behaviour is very likely to have supported the expansion of the species in Central Europe and will most probably continue to do so in the future (Zoller and Drygala, 2013).

PROBABILITY OF IMPACT

Important instructions:

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

QUESTION	RESPONSE	CONFIDENCE	COMMENTS
2.10. How great is the economic loss caused by the organism within its existing geographic range, including the cost of any current management?	major	medium	The raccoon dog is not known to cause much economic loss in its native area, although information is scarce (Kauhala and Saeki 2004, Karlsson 2013). Keuttunen (2009) evaluated a cost of 0.43 million/year for control of *Nyctereutes procyonoides* for Lithuania and Sweden extrapolated to 0.92 million/year for Europe. However, in other cases it was not possible to separate cost of *Nyctereutes procyonoides* and other species control: 0.03 million/year control *Mustela vision/ Nyctereutes procyonoides*, 0.07 for a pool of species Local agricultural damages are sometimes reported, especially in maize exploitations and in commercial crops of low hanging fruits (strawberries, blueberries, blackberries, etc.) but outcome is probably not significant (G.O.N. 2005, Mulder 2011, Rauel 2011). Raccoon dog do not climb easily, which implies that it doesn't predate on pets or poultry (Mulder 2011). On the other hand, preventive and curative measures

			that have to be taken to prevent the expansion of diseases and parasites transmitted by raccoon dog can lead to considerable costs, especially for rabies control, but also emergence of Trichinella ssp. amongst pigs (Pannwitz et al. 2010).
2.11. How great is the economic cost of the organism currently in Europe excluding management costs (include any past costs in your response)?	major	medium	Disease management and prevention constitutes the largest economic costs to date. Bait vaccinations against rabies are performed in northeastern Europe, as twice each year in Finland (Holmala & Kauhala 2006). The cost for testing and vaccination treatments estimated in 2012 in Finland is around 270,000 EUR, and this doesn't include the destruction, disinfection, salaries, equipments (European Commission 2012). There are also substantial private costs associated with the rabies threatment. In Finland private dog owners have to vaccinate their animals after the last outbrake in the late eighties, where the raccoon dog was the main vector of the disease (Westerling 1991, Kauhala & Kowalczyk 2011). Since the vector density have multiplied after the raccoon dogs arrival in the rest of western and central Europe, also the rabies control have to be intensified. To what extent this have been done due to the raccoon dog is however uncertain. According to Layman report of LIFE09 NAT/SE/000344 in Finland they are today trying to stop new outbreaks of rabies, which were essentially found in raccoon dogs in their last outbreak in the late eighties. The cost of this preventive management in the form of medicating immigrating predators from Russia and vaccination of dogs cost approximately one million Euros per year. Because the species is an important vector of rabies in northeastern Europe (Holmala and Kauhala, 2006; In: CAB International 2012), bait vaccinations were carried

			out, e.g. in Finland twice each year (autumn and spring). The cost of this is considerable. At present they are carried out only in autumn.
2.12. How great is the economic cost of the organism likely to be in the future in Europe excluding management costs?	major	high	If the species is established in other areas, damage reported in point 2.11 could be major. Since available data are limited there is a high incertitude in these predictions. Rabies management is mainly done by either lowering the vector density to below a threshold value or by bait vaccination of vectors (Holmala 2009). Adding the raccoon dog to the vector system will make the situation much worse, few areas in Europe will in the future be able to be without rabies control, and where it already exist the costs will multiply because of the increased vector density (Holmala & Kauhala 2006). The whole community of susceptible animals to rabies has to be taken into consideration in a multi-species model, and not only in one species model (Holmala 2009).
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	Keuttunen (2009) evaluated a cost of 0.43 million/year for control of *Nyctereutes procyonoides* for Lithuania and Sweden extrapolated to 0.92 million/year for Europe. However, in other cases it was not possible to separate cost of *Nyctereutes procyonoides* and other species control: 0.03 million/year control *Mustela vision/ Nyctereutes procyonoides*, 0.07 for a pool of species The cost to control an established population of raccoon dogs for the nine million hectares of wetlands in Sweden was estimated to be 29.7 million euro per year (Dahl et al., 2010). Given the close association also to other habitats, the cost of their control could be much higher if they expand their range further. Secondly, the

			lack of clear habitat association of dispersing individuals suggests that there are no typical movement corridors in which management actions would be particularly efficient at stopping dispersers. Therefore, it seems even more important to prevent further expansion of raccoon dogs, as delaying such actions will most likely result in considerably higher cost (Melis et al, 2015). In comparison to data provided by FurEurope, about total sales in a year (16,8 mill. €), it seems that public cost may be higher. As described in NOBANIS (https://www.nobanis.org/globalassets/speciesinfo/n/nyctereutes-procyonoides/nyctereutes_procyonoides-final.pdf): In Finland, the annual hunting bag varied between 98,000-172,000 in 1998-2009 (Kauhala and Saeki 2004a, Finnish Game and Fisheries Research Institute 2010), c.a. 20,000 in Germany (S. Schwarz, pers. comm), 6,000-10,000 in Poland (data of Research Station of Polish Hunting Society in Czempiń), 4,000-5,000 in Estonia, 3,500-4,000 in Lithuania (L. Baltrūnaitė, pers. comm), and 2,000 in Latvia. In other countries raccoon dogs are hunted occasionally. In Germany about 35 000 raccoon dogs were killed in 2008 (Mulder 2012). In the Nordic countries a LIFE+ project has been conducted 2010-2013 with a budget of 5.3 million Euro. Today the annual cost for this management is approximately 800.000 Euro in Sweden, 200.000 Euro in Denmark and 200.000 in Finland. According to Layman report of LIFE09 NAT/SE/000344 the cost of management (predator control) of valuable wetlands (bird recruitment areas)

			cost 3.3 Euros annually per hectare, and then the work has to be done voluntarily. There is a lack of clear economic data, probably because a lack funding on wildlife research. Having in mind the Report of Raccoon Dog management in Finland for 2015 (https://jagareforbundet.se/globalassets/global/mardhundsprojektet/dokument/raccoondog_finland_2015_report.pdf) and considering only the 100 individuals harvested this year and the cost items for 2015 of 163.820,38 € we can make a rough approximation around 1638 € per raccoon dog harvested. So, comparing to the average auction price for the Finn raccoon skins that is around 120 € during the recent years, it seems there is a higher public spending on control that the benefit derived from the sale of the skin. If the species spread to other European countries there will be a need for huge budget to control the species however this can be avoided limiting its sale and establishing a European action plan to control the species.
2.14. How great are the economic costs associated with managing this organism likely to be in the future in Europe?	major	medium	Very difficult to assess. From the current management in the Nordic countries as a base probably at least 1 million Euro annually for each country where the raccoon dog is established or are about to establish. In the Nordic example only parts of the countries are managed actively. In large parts of Europe there are land-locked borders between most countries making the management more difficult and expensive. On the other hand, the Nordic raccoon dog project has also demonstrated that the same management system can be used for other invasive alien predators as well, such as the raccoon. This is today done in Sweden and Denmark, without or with very low extra cost for the

			raccoon management (Dahl et al. 2013, 2015, Alhainen 2015). Apart for the management of the species for protecting the native fauna, rabies management will also be necessary according to above
2.15. How important is environmental harm caused by the organism within its existing geographic range excluding Europe?	minor	medium	The raccoon dog is not known to cause much environmental harm in its native area, although information is scarce (Kauhala and Saeki 2004, Karlsson 2013). The IUCN (https://portals.iucn.org/library/sites/library/files/documents/Rep-2016-001.pdf) consider within a high magnitude of impact, meaning irreversible impact on indigenous wildlife and the wider ecosystem if the following species are farmed in non-native regions with weak environmental regulations or no management plans: North American Mink (*Mustela vison*), brushtail possum (*Trichosurus vulpecula*), coypu (*Myocastor coypus*), muskrat (*Ondatra zibethicus*), raccoon (Procyon lotor) and raccoon dog (*Nyctereutes procyonoides*). Two of the species - possum and coypu - are listed on the GISD's '100 of the World's Worst invaders'.
2.16. How important is the impact of the organism on biodiversity (e.g. decline in native species, changes in native species communities, hybridisation) currently in Europe (include any past impact in your response)?	major	medium	The raccoon dog impacts on native species and communities were moderately negative for amphibians, mollusks, rodents, birds, insects, and reptiles, and for transmission of pathogens (Pūraitė et al., 2011). Evidences reviewed by Mulder (2011) for Risk Assessment in The Netherlands. The raccoon dog is an omnivorous, medium sized predator of which the ecology shares aspects with several native and non-native predators: badger, red fox, polecat and American mink. Since the American mink is a non-native species itself, and nothing is known about its relations with the

			raccoon dog, the species of interest here are the badger, the red fox and the polecat. Impact through competition can be interference competition or resource competition (Pianka, 1978). Raccoon dogs may be a serious threat for small isolated populations of amphibians, and probably also for turtles (Mulder, 2011). Direct interference of raccoon dogs with badgers seems to be rare. Only one example was found in the literature: the remains of a badger cub have been found in raccoon dog scats in Bialowieza Primeval Forest (Jędrzejewska & Jędrzejewski, 1998). More often badgers kill raccoon dog pups (Kowalczyk et al., 2008). Once an adult raccoon dog was observed which had died of wounds, inflicted on its back parts by most probably a badger (Drygala, 2009). Interference with foxes probably is much more common and both species occasionally kill cubs of the other species. In northeast Germany fox numbers (measured as number of foxes shot annually) decreased in the first period after the arrival of the raccoon dog, but this effect disappeared later (Zoller, 2006). An enhanced infection rate with sarcoptic mange, which is more common in raccoon dogs, might have been responsible for this temporary decline in the fox population. Drygala (2009) concludes that in Europe competition between raccoon dog, red fox and badger might take place, but that it is unlikely that the competition is very severe, leading to the significant decrease of either of the species. Raccoon dogs forage while slowly walking, mostly in dense vegetation. They do not 'hunt' like foxes, chasing their prey species. Upon encountering bird nests, they will eat the eggs and chicks, rarely the adult breeding bird. However, remains of eggs in raccoon dog stomachs are rare in diet studies.

			According to most authors, the added impact (on top of the impact of native predators such as the red fox) of the raccoon dog on the breeding success of ground nesting birds will probably be negligible. However, solid research into the impact of the raccoon dog on its prey species is still lacking. The predictions in this section are thus mainly based on expert judgment. Especially in bird colonies in wetlands (e.g., greylag goose *Anser anser*, black-headed gull (*Larus ridibundus*) raccoon dogs might have a considerable impact, destroying many nests in a short time. For the Netherlands, with its many wetlands in low lying areas, including many Natura 2000 areas, the most vulnerable species will probably be the purple heron *Ardea purpurea* colonies, the black tern *Chlidonias niger* colonies and the solitary bittern *Botaurus stellaris*. Although already in most of these wetlands the red fox has arrived in recent years, the raccoon dog may pose an added threat because of its greater readiness to swim. The abovementioned species are possibly at risk and measures to prevent predation by raccoon dogs may be necessary in the future. Its preference for amphibians may lead to local declines of more or less isolated populations of frogs and possibly newts, for instance in and around cattle drinking ponds in the dryer east and south of the Netherlands. Raccoon dogs also forage on grass snakes *Natrix natrix* (Drygala, 2009), and might be a threat to isolated populations of this species as well. The common practice of protecting amphibians from being killed on the road in spring, by erecting fences and catching the animals in buckets during the night, may in the future attract the unwelcome attention of raccoon dogs, gathering an easy meal from the buckets (Puffpaff, 2008).

			As informed by Swedish experts, in a recent and ongoing study Dahl et al. (in prep) investigates the effect of the raccoon dog as an egg predator in the north Swedish archipelago (Dahl et al, unpublished data). Parts of this archipelago (Haparanda Skärgård National Park) are protected, among other reasons due to its unique bird fauna, several of which are threatened (Council Directive 92/43/EEG, 79/409/EEG). Since 2008 more than 50 raccoon dogs has been equipped with GPS transmitters to be able to follow their movements in northern Sweden. At least 10 of the collared raccoon dogs had been moving naturally in the archipelago during the breeding time of ground nesting sea birds. Often the raccoon dogs were moving between islands, swimming quite long distances, lingering on one island for some week(s), and then moving on to the next island. In summer of 2015 artificial nests, with three eggs each, were constructed by natural materials on two islands, mimicking natural nests and placement as far as possible (ten nests per island). A game camera was directed towards each nest during the study to be able to determine their faith. One GPS collared raccoon dog was released on each island. Nests were predated rapidly when raccoon dogs were present on the islands. After 10 days all but one out of 19 nests were predated (one camera malfunctioned and this nest was taken out of the study). In 16 out of 18 cases raccoon dog was the predator. All but one predated nest were revisited several times after the nests had been predated. The raccoon dogs left the study islands and moved to neighbouring islands after 7 and 9 days respectively, possibly due to food shortage. When the study was repeated without raccoon dogs present, only 1 out of 19 nests were predated by natural predators after 20 days, all other nests were intact. This pilot study found that;

			1. Raccoon dogs move naturally in the archipelago during the breeding time of ground nesting sea birds, swimming several km to reach new islands, 2. The Raccoon dog eats eggs, 3. Even though the use of dummy nests is far from a perfect method to investigate egg predation, the raccoon dog is very likely to have an additive effect on other egg mortality. The size of the raccoon dog suggests that a sea bird would hardly be able to protect its nest against it if they can find the nest. And according to the results the raccoon dogs were traversing the islands repeatedly until there was very little left to eat before they moved on to the next island. Especially for endangered ground nesting sea bird species such as the Caspian Tern *Sterna caspia* nesting on a few islands in the Swedish archipelago the raccoon dog is a very serious threat if it gets established since their densities can become extremely high. Also at present with a very small population of raccoon dog due to intense management it is very likely that if one single raccoon dog found its way to the main nesting island Rödkullen, there would be no reproduction that year. This still ongoing study will be continued 2016 with more artificial nests and with natural nests. The American mink is another invasive alien mammalian predator that utilise wetlands and archipelagos and where more studies have been made than for the raccoon dog. Nordström et al. (2003), show that when the mink was removed from the area the breeding densities of ringed plover (*Charadrius hiaticula*), arctic skua (*Stercorarius parasiticus*), arctic tern (*Sterna paradisaea*) and rock pipit (*Anthus petrosus*) increased markedly in the removal areas in comparison to the control areas. They further showed that two species already extinct in one of the removal areas, razorbill (*Alca torda*) and black guillemot (*Cepphus grylle*),

			returned to breed in the area (Nordström et al. 2003). The raccoon dog is as good, or even a better swimmer than the mink. It is further much larger and thus will be difficult for the birds to drive away from the nest. And even if the raccoon dog is temporarily driven away, the ongoing study in the Swedish archipelago show that they will revisit most nests several times (Dahl et al. in prep.). In an ongoing study Dahl and Ahlen (2016) are investigating; 1. How and when raccoon dog move in the archipelago of northern Sweden, 2. If raccoon dogs arriving to an island will find hidden nests and eat the eggs, 3. If egg predation by raccoon dog is additive or compensatory to predation from natural predators. In summer of 2015, 20 artificial nests were constructed on two islands. One GPS collared raccoon dog was released on each island. A game camera was directed towards each nest during the study to be able to determine their faith. After 9 days all but one nest were predated when raccoon dogs were present on the islands. In 16 cases raccoon dog was the predator. When the study was repeated without raccoon dogs present only 1 nest was predated after 20 days, all other nests were intact. In summer of 2016 the experiment will be repeated, both with artificial and natural nests.
2.17. How important is the impact of the organism on biodiversity likely to be in the future in Europe?	moderate	medium	The raccoon dog is very adaptable to climate and habitat and will establish over all of Europe if it is not actively managed (Kowalczyk 2014). The raccoon dog is already the most common carnivore in Finland and the Baltic countries (Kowalczyk 2014). The raccoon dog impacts on native species, particularly

			birds and amphibians, are considered from moderate to important accordingly to different authors. The occurrence of birds in the diet increases with latitude, with a higher consumption in northern Europe (Sutor et al., 2010). Birds eaten by raccoon dogs are mainly passerines (Kauhala, 2009; Sutor et al., 2010). However, it is not known whether this predator have caused a decline in passerine populations. The impact on game bird is probably minor; excluding some some area in Finland, where waterfowl or grouse remains were found only 0–5% of the feces or stomachs (Kauhala, 2009). Raccoon dog probably consumed many of the non-passerine birds as carcasses (Novikov, 1962; Barbu, 1972; Woloch and Rozenko, 2007; Kauhala and Auniola, 2001). Amphibians (e.g., *Rana* spp., *Bufo* spp., *Bombina* spp. and *Triturus cristatus*) are common in the diet of raccoon dogs in spring and summer (e.g., Ivanova, 1962; Lavrov, 1971; Barbu, 1972; Viro and Mikkola, 1981; Kauhala et al., 1993a, 1998a; Jędrzejewska and Jędrzejewski, 1998; Sutor et al., 2010). This may have an impact on populations, especially on islands and in isolated areas (Kauhala and Auniola, 2001; Sutor et al., 2010). In a predator removal study in Finland *N. procyonoides* was not observed to cause harm for waterfowl or grouse (Kauhala et al., 2000; Kauhala, 2004). In a nest predation study in Latvia, they destroyed only 0.6% of the nests destroyed by predators (0.3% of all nests) (Opermanis et al., 2001). There is no proof that native carnivore populations in northern Europe decreased after colonisation by this species the area; the exception may be Belarus where many carnivore populations have decreased during the past few decades (Sidorovich et al., 2000).

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	low	Very little work has been done to answer this question. It is unlikely that the raccoon dog have large effect on e.g. habitat change and nutrient cycling. Except for some small island situations, it not likely that raccoon dogs will have a substantial impact, directly or indirectly, on ecosystems as a whole, e.g. by disrupting the existing food webs (Muldel, 2011).
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	If the raccoon dog is established at high densities there are possibility of effects on some ecosystem services such as the Provisioning (food supply), Regulation (disease regulation, pest and disease control) and Cultural Services (recreation and values). Human wellbeing and health will be affected by the facilitation of the raccoon dog in the introduction and spread of pathogens and parasites such as rabies and *Eccinococcus multilocilaris.*
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	medium	In Finland Kauhala and Kowalczyk (2012) indicate locally the raccoon dog may be an important threat to populations of waterfowl and amphibians. There is however no confirmed decline of conservation status due to the raccoon dog anywhere in Europe yet. This is however not particularly surprising considering the limited time the species have been present at high densities in most of Europe until to date, and the scarcity of scientific studies made to investigate this particular question.
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	If the raccoon dog is allowed to establish without control it will probably become one of the most numerous predator in many parts of Europe, although not a particularly effective predator (Kowalczyk, 2014). It will however most likely have a negative impact locally on some endangered bird and amphibian species.

			The muskrat (*Ondatra zibethicus*) and the raccoon dog (*Nyctereutes procyonoides*) are known to cause impacts in more than 50 European regions (Hulme et al., 2010).
2.22. How important is it that genetic traits of the organism could be carried to other species, modifying their genetic nature and making their economic, environmental or social effects more serious?	minimal	high	The raccoon dog is quite an isolated species in the canid family, and hybridisation with other dog species is unknown, even in captivity. There is, therefore, no risk of genetic effects on native species (Muldel, 2011).
2.23. How important is social, human health or other harm (not directly included in economic and environmental categories) caused by the organism within its existing geographic range?	major	high	The raccoon dog is one of the main vector of rabies in Europe (Kowalczyk, 2014, Kauhala and Kowalczyk, 2012, Singer et al 2009, Holmala & Kauhala 2006, and references therein). In the 1990s in Poland, Lithuania, Latvia and Estonia, from 7 to 16% of all rabies cases were found in raccoon dogs. In Estonia, > 50% of wildlife rabies cases were found in raccoon dogs in 2004. In 1999-2004 in Poland over 700 raccoon dogs (i.e. 8 % of all cases) with rabies were recorded. During rabies epizootic in Finland in late 1980s, 77% of the cases identified were in raccoon dogs (Westerling 1991). Raccoon dogs are potential vectors of *Echinococcus multilocularis*, a parasite dangerous for humans (Thiess et al. 2001). The prevalence found in raccoon dogs are usually lower than that of red fox in the same are, however, considering that the raccoon dog is becoming increasingly widespread and is already abundant in several countries in Europe, the role of the species must be taken seriously when assessing the *E. multilocularis* related risks to public health (Laurimaa et al. 2015, Schwarz et al 2011). Results of studies from Finland and Germany furthermore showed that biological characteristics of the raccoon dog make this carnivore an ideal host and vector for a variety of pathogens

			(Sutor et al. 2014).
2.24. How important is the impact of the organism as food, a host, a symbiont or a vector for other damaging organisms (e.g. diseases)?	major	high	High population densities and the potential for range extension of vector species pose important risk factors for the distribution of wildlife diseases (Gortázar et al. 2007). The species is widely distributed in Europe, it reaches high population densities in large, and it is a potential vector for a plethora of pathogens. The establishment of the raccoon dog as a further vector species may increase health risks for livestock, wildlife, and humans and could have a negative impact on wildlife conservation projects (Sutor et al 2014). Drygala et al (2016) found remarkable results in the sense that they identified a homogenous genetic cluster inhabiting an area stretching over more than 1500km. Other invasive mammals have been shown to maintain genetic structure during introduction and similarly exhibit homogenous genetic structure covering larges spatial distances. The population genetic structure of native carnivores, even if they are highly mobile, is frequently, but not always, affected by habitat specialisation, climate, habitat barriers or simply geographic distance. In South Korea, the raccoon dog is also characterised by significant genetic structuring. In Germany, the mean and maximal life-time dispersal distance of 59 marked raccoon dogs was 13.5 km and 91.2 km respectively. Theory has shown that the rate of dispersal of individual animals and plants should increase towards the front of an expanding geographic range. In other words, the homogenous population genetic structure observed in the raccoon dog in Europe is probably a result of its fairly rapid population expansion after introduction. In this sense, the results presented by Drygala et al (2016) have great relevance for disease management. First, the extent of its genetic

			homogeneity suggests the lack of any substantial landscape barrier to dispersal. Secondly, the absence of a (strong) IBD pattern (isolation-by-distance), as well as some direct evidence from their assignment results, suggests frequent long-distance dispersal. This is in line with the speed of the historic spread of the species, as well as with several field studies reporting raccoon dog dispersal over large distances in relatively short period of time, particularly as a result of long-distance dispersal of young raccoon dogs. Thus, in the event of a significant rabies outbreak, there is a great risk of a rapid virus spread among raccoon dog populations.
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)	NA		
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	Several studies point out that the raccoon dog in several parts of Europe already is the most numerous predator, and will become the most numerous in all of Europe if not managed (Kauhala 2011; Kowalczyk, 2014). Wolves or other natural predators have no possibility to control the raccoon dog population Large predators have territories they defend against conspecifics and i.e. a pack of wolves just won't need so much food or are able to kill enough raccoon dogs to reduce the population for interference competition that it would control the raccoon dog population. The high reproduction of the raccoon dog makes them outnumber the predators that naturally kill them. Density dependent reproduction also kicks in if the raccoon dog population is reduced, that is the number of pups born increases if the population get lower (Kowalczyk, 2014).

			Raccoon dogs are known vectors of several diseases dangerous to both natural wildlife and humans such as rabies and *Eccinoccoccus multilocularis*. There are no evidence that diseases could limit raccoon dog populations.
2.27. Indicate any parts of Europe where economic, environmental and social impacts are particularly likely to occur (provide as much detail as possible).	Most of Europe	high	In most of Europe there may be an impact, because the species is widely distributed, often with high densities. In particular vulnerable wetlands, islands and archipelagos will be severely affected regarding the environmental issues. Most of Europe will be affected by the increased risk for dangerous diseases due to the extremely high densities the raccoon dog reaches compared with the natural predators.

RISK SUMMARIES			
	RESPONSE	**CONFIDENCE**	**COMMENT**
Summarise Entry	very likely	very high	The species is already present in a wide part of Europe.
Summarise Establishment	very likely	very likely	The species is established in many countries in northern and central Europe. During the last decade, a further range expansion of racoon dog into Mediterranean areas has been shown by road-killed individuals.
Summarise Spread	very likely	very high	The combination of favourable circumstances, efficient breeding system and flexible behaviour is very likely to have supported the expansion of the raccoon dog in Central Europe and will most probably continue to do so in the future (Zoller and Drygala, 2013). There are trends of further range expansion towards South and Western Europe. It is expected that the raccoon dog will expand its range in the already invaded countries very quickly (Kauhala and Winter, 2006). From the first observation in the eastern part of the country in 1955 it took only 15 years for the raccoon dog to spread and establish all over Poland (Kauhala & Kowalczyk, 2011). The lack of clear habitat association of dispersing individuals suggests that there are no typical movement corridors in which management actions would be particularly efficient at stopping dispersers. Therefore, it seems even more important to prevent further expansion of raccoon dogs, as delaying such actions will most likely result in considerably higher cost (Melis et al, 2015).
Summarise Impact	major	medium	The raccoon dog impacts on native species, particularly birds and amphibians, are considered from moderate to

			important accordingly to different authors The raccoon dog is a very important vector of rabies, sarcoptic mange, trichinellosis and *Echinococcus multilocularis*. This is no doubt the most severe consequence of the colonization of this alien species in Europe. Most of the information on the raccoon dog impact comes from unpublished sources or grey literature. While some caution should be considered pending the publication of more data in peer review journals, it is undeniable that these unpublished data highlight an impact that might be relevant, for example on ground nesting birds. The data provided by fur Europe point out that there is a business around these species, connected to the fur farms. However, experts highlight cost of control that could be higher of the venues from fur farming, Therefore using both data it should be reported that if the species is banned, pros could be higher than cons.
Conclusion of the risk assessment	high	medium	The species is already widely distributed in Europe, especially in northern and central Europe. The species could further spread in other regions and there is evidence of a spread also in Mediterranean countries. A large number of scientific publications demonstrate the invasiveness of this species. The raccoon dogs impacts on native species, particularly birds and amphibians, are considered from moderate to important accordingly to different authors. Furthermore they act as an important disease vector for both fauna and humans and will further affect both the economy and society in Europe in a negative way. Some projects in northern Europe demonstrate that the

			species could be managed efectively. Though, considering the present range and the possibility of future spread it is important a European approach on the management of the species. There is an urgent need for a European wide early warning and detection system to monitor the spread of the species and possibly limit it. It is necessary to share information and experiences and to prepare countries for the arrival of the raccoon dog. The inclusion of the species on the Union list will help in prevent or mitigate the species adverse impacts

ADDITIONAL QUESTIONS - CLIMATE CHANGE			
3.1. What aspects of climate change, if any, are most likely to affect the risk assessment for this organism?	Temperature	high	Climate change will have a positive effect of the species distribution, especially in northern countries. Northern range is limited by annual mean temperature below 0°C, a snow cover of 800 mm, the duration of the snow cover of 175 days and length of growing season of 135 days (Larov 1971, Helle & Kauhala 1991). Until the late twentieth century their physical range to the north was up to Oulu in northern Finland. Only a few single animals were sporadically found in northern Sweden and Norway (Melis et al. 2007). The climate has however changed the last 20-30 years (SMHI). In Northern Sweden the mean annual temperature have become several degrees higher and now exceeds the temperature limit for population establishment. In 2006 the first reproduction was found in Northern Sweden. Raccoon dogs, are today found also in the far north of Sweden, Norway and Finland (Dahl et al. 2015). If climate continue to get warmer the conditions for the raccoon dog to spread and establish in the far north of Europe even more will improve.
3.2. What is the likely timeframe for such changes?	20 years	medium	In Norway Melis et al (2007) consider the expansion pattern changed considerably when they simulated climatic change by increasing the growing season by ten or 35 days. First, they find a large increase in available habitat to sustain viable populations, particularly in the 35-days increase scenario. Second, with the 10-days increase, several new corridors occur along the border between Sweden and Norway up till Trøndelag. With the 35-days increase, potential corridors are present even at the northernmost county, Finnmark, where invasion from Finland now become probable. Only the

			most alpine areas at the Fennoscandian peninsula now operate as real barriers, slowing down the invasion rate.
3.3. What aspects of the risk assessment are most likely to change as a result of climate change?	[spread]	medium	Racoon dog occurs from southern China to south-eastern Russia and in many part of Europe. CLimate change will facilitate the spread of the species at northern latitudes (see point 3.1) increasing the risk of negative effects.).
ADDITIONAL QUESTIONS - RESEARCH			
4.1. If there is any research that would significantly strengthen confidence in the risk assessment please summarise this here.	[The impact to native fauna should be further investigated and cost of disease control]	medium	A nationwide monitoring program for raccoon dogs is recommended for countries were the species is established or spreading. It should focus on distribution and role of raccoon dog in ecosystems, as a vector of diseases and parasites, and its impact on native fauna. (Further experiment to evaluate impacts of preys are needed

REFERENCES:

- Alhainen (2015). Report of Raccoon Dog management in Finland for 2014, Finnish Wildlife Agency.
- ANSE – Asociación Naturalistas del Sureste (2010) http://anseblog.blogspot.com.es/2008/06/perro-mapache-en-murcia.html
- Ansorge, H. & Stiebling, U. (2001). Die Populationsbiologie des Marderhundes (*Nyctereutes procyonoides*) im östlichen Deutschland - Einwanderungsstrategie eines Neubürgers? Beiträge zur Jagd- und Wildforschung 26, 247-254.
- Ansorge, H. & Stiebling, U. (2001). Die Populationsbiologie des Marderhundes (Nyctereutes procyonoides) im östlichen Deutschland - Einwanderungsstrategie eines Neubürgers? Beiträge zur Jagd- und Wildforschung 26, 247-254.
- Asikainen J., Mustonen A.M., Nieminen P., Pasanen S., Araja-Matilainen H. (2002). Reproduction of the raccoon dog *Nyctereutes procyonoides* after feeding or food deprivation in winter. J. Anim. Physiol. Anim. Nutr. 86: 367–375.
- Baiwy, E., Schockert, V. & Branquart, E. (2013). Risk analysis of the raccoon dog *Nyctereutes procyonoides*, Risk analysis report of non-native organisms in Belgium. Cellule interdépartementale sur les Espèces invasives (CiEi), DGO3, SPW / Editions, 37 pages
- Barbu P. (1972). Results of studies of raccoon dogs Nyctereutes procyonoides ussuriensis Matschie, 1907, from the Danube Delta. Säugetierkundliche Mitteilungen 20: 375–405 (In German).
- CAB International (2012). Invasive Species Compendium. http://www.cabi.org/isc/ (accessed on 05.2015).
- Ćirović D. (2006). First record of the raccoon dog (*Nyctereutes procyonoides* Gray, 1834) in the former Yugoslav Republic of Macedonia. European Journal of Wildlife Research. Volume 52, Issue 2, pp 136-137
- Dahl F, Åhlén P, Granström Å (2010) The management of raccoon dogs (*Nyctereutes procyonoides*) in Scandinavia. Aliens 30: 59–63.
- Dahl F., Åhlén P-A, Swartström J., Lindström M., Simmelsgaard Platz M.L. (2013). LAYMANS REPORT. Management of the invasive Raccoon Dog (*Nyctereutes procyonoides*) in the north-European countries LIFE09 NAT/SE/000344
- Dahl, F. (2009). The Swedish Raccoon Dog Project - adaptive management of an invasive species. CICNewsletter/4: 14-16.
- Dahl, F., Åhlén, P. A., Platz, M. L. S. and Lindström, M. (2013). Conference Report; Invasive Alien Predators - Policy, research and management in Europe Avaliable at: http://jagareforbundet.se/Global/Mardhundsprojektet/Dokument/Conference%20Report_webb_final.pdf
- Dahl F. & Åhlén P-A (2016) Egg predation by raccoon dog Nyctereutes procyonoides in the archipelago of northern Sweden. In: Natural resources and bioeconomy studies 21/2016. https://jukuri.luke.fi/bitstream/handle/10024/534847/luke_luobio_21_2016.pdf?sequence=4
- Delivering alien invasive species inventories for Europe (DAISIE) (2010). – DAISIE European Invasive Alien Species Gateway. European Commission. Available at: www.europealiens.org/ (accessed on 11 May 2015)
- Drygala F., Werner U., Zoller H. (2013). Diet composition of the invasive raccoon dog (*Nyctereutes procyonoides*) and the native red fox (*Vulpes vulpes*) in north-east Germany. Hystrix, the Italian Journal of Mammalogy. Volume 24 (2): 190–194
- Drygala, F. (2009). Space use pattern, dispersal and social organisation of the raccoon dog (Nyctereutes procyonoides GRAY, 1834) an invasive, alien canid in Central Europe. Thesis, Technische Universität Dresden. 125 pp.

- Drygala F., Korablev N., Ansorge H., Fickel J., Isomursu M., Elmeros M., Kowalczyk R., Baltrunaite L., Balciauskas L., Saarma U., Schulze C., Borkenhagen P., Frantz A.C. (2016) Homogenous Population Genetic Structure of the Non-Native Raccoon Dog (*Nyctereutes procyonoides*) in Europe as a Result of Rapid Population Expansion. PLOSone. http://dx.doi.org/10.1371/journal.pone.0153098
- Fløjgaard C., Morueta-Holme N., Skov F.; Bo Madsen A.; Svenning J.-C.Potential (2009). 21st century changes to the mammal fauna of Denmark – implications of climate change, land-use, and invasive species. IOP Conf. Series: Earth and Environmental Science 8 012016
- Gortázar C., Ferroglio E., Höfle U., Frölich K., Vicente J. Diseases shared between wildlife and livestock: a European perspective Eur. J. Wildl. Res., 53 (2007), pp. 241–256
- Groupe Ornithologique et Naturaliste (G.O.N.) du Nord - Pas-de-Calais (2005) Les espèces animales invasives des milieux aquatiques et humides du bassin Artois-Picardie. Agence de l'eau, Artois-Picardie.
- Helle E & Kauhala K (1991). Distribution history and present status of the raccoon dog in Finland. Holarctic Ecol. 14: 278–286.
- Helle E. and Kauhala K. (1995). Reproduction in the raccoon dog in Finland. Journal of Mammalogy 76:1036-1046
- Holmala, K. & Kauhala, K. (2006) Ecology of wildlife rabies in Europe. Mammal Review 36: 17–36.
- Holmala, K. (2009) The community of medium-sized carnivores: the interactions between species, habitats and rabies. Thesis University of Helsinki.
- Hulme E., Vilà M., Nentwig W. & Pyšek P. (2010). Are the Aliens Taking Over? Invasive Species and Their Increasing Impact on Biodiversity. Atlas of Biodiversity Risk Chapter 6 pp 132-133
- Ivanova GI. (1962). Comparison of the diets of the red fox, badger and raccoon dog in Voronez national Park. Ucenye Zapiski/Moskovskij Gosudarstvennij Pedagogičeskij Institut im. V. I. Lenina 186: 210–256 (In Russian).
- Jędrzejewska, B. & Jędrzejewski, W., 1998. Predation in Vertebrate Communities: The Białowieża Primeval Forest as a case study (Ecological Studies). Berlin-Heidelberg-New York-Tokyo: Springer Verlag 135: 215–219. [ref]
- Judin VG (1977). Raccoon dog in Primorje and Priamurye. Izd. Moscow: Nauka, 76–98 (In Russian).
- Karlsson F. (2013). Självständ i g t a r b e t e i b i o lo g i , 1 5 h p , v å rtermin e n 2 0 13,Institution e n f ö r b i o log is k g r u ndutbildnin g , U p ps a l a u n iversitet.
- Kauhala K (1996) Habitat use of raccoon dogs (Nyctereutes procyonoides) in southern Finland. Z. Säugetierkunde 61:269-275
- Kauhala K (1996) Introduced carnivores in Europe - a review. Wildlife Biology 2:197-204.
- Kauhala K (1996) Reproductive strategies of the raccoon dog and the red fox in Finland. Acta Theriologica 41:51- 58
- Kauhala K. (2004). Removal of medium-sized predators and the breeding success of ducks in Finland. Folia Zoologica 53: 367–378.
- Kauhala K, Auniola M. (2001). Diet of raccoon dogs in summer in the Finnish archipelago. Ecography 24: 151–156.
- Kauhala K, Helle E (1994) Home ranges and monogamy of the raccoon dog in southern Finland. Suomen Riista 40:32–41
- Kauhala K, Helle E, Pietila H (1998) Time allocation of male and female raccoon dogs to pup rearing at the den. Acta Theriol 43:301–310
- Kauhala K, Helle P, Helle E. (2000). Predator control and the density and reproductive success of grouse populations in Finland. Ecography 23: 161–168.

- Kauhala K. (1996b). Reproductive strategies of the raccoon dog and the red fox in Finland. Acta Theriologica 41[1], 51-58.
- Kauhala K. (2004). Removal of medium-sized predators and the breeding success of ducks in Finland. Folia Zoologica 53: 367–378.
- Kauhala K. and Saeki M. (2004a). Raccoon dogs. [In: Canids: Foxes, Wolves, Jackals and Dogs. Status Survey and Conservation Action Plan. C. Sillero-Zubiri, M. Hoffmann and D. W. Macdonald (eds.)]. IUCN/SSC Canid Specialist Group, Gland, Switzerland and Cambridge, UK: 136-142.
- Kauhala K. (1993). Growth, size, and fat reserves of the raccoon dog in Finland. Acta Theriologica 38[2], 139-150.
- Kauhala K., Kowalczyk R. (2011). Invasion of the raccoon dog *Nyctereutes procyonoides* in Europe: History of colonization, features behind its success, and threats to native fauna – a review. Current Zoology 57(5): 584–598.
- Kauhala, K. & Kowalczyk, R. (2012). The raccoon dog (*Nyctereutes procyonoides*) in the community of medium-sized carnivores in Europe: its adaptations, impact on native fauna and management of the population. Animal science, issues and professions carnivores species, conservation, and management Nova Publisher New York (pp. 113-134) ISBN: 978-1-62257-323-3
- Kauhala, K. & Saeki, M. (2008). *Nyctereutes procyonoides* (On-line) In: IUCN 2012 - IUCN Red List of Threatened Species. http://www.iucnredlist.org (accessed on 05.2012).
- Kauhala, K. & Winter, M. (2006). *Nyctereutes procyonoides* (On-line) In: DAISIE. http://www.europe-aliens.org (accessed on 05.2015).
- Kauhala, K. (2012) *Nyctereutes procyonoides* (raccoon dog) datasheet (On-line) In: CAB International 2012 - Invasive Species Compendium. http://www.cabi.org/isc/ (accessed on 05.2015).
- Kettunen, M., Genovesi, P., Gollasch, S., Pagad, S., Starfinger, U. ten Brink, P. & Shine, C. (2008). Technical support to EU strategy on invasive species (IAS) - Assessment of the impacts of IAS in Europe and the EU (final module report for the European Commission). Institute for European Environmental Policy (IEEP), Brussels, Belgium. 44 pp. + Annexes.
- Kim S.-I.; Oshida T.; Lee H.; Min M.-S.and Kimura J. (2015) Evolutionary and biogeographical implications of variation in skull morphology of raccoon dogs (Nyctereutes procyonoides, Mammalia: Carnivora). Biological Journal of the Linnean Society. Volume 116, Issue 4, pages 856–872
- Kirbiš N. (2012) Dravsko polje – another observation of the raccoon dog *Nyctereutes procyonoides* (Gray, 1834) in Slovenia Natura Sloveniae 15(1): 43
- Kobylińska J. (1996). The red fox and raccoon dog in wetlands of the Biebrza River Valley: Food composition and burrow use. Eur. J. Wildl. Res.: 186–189.
- Kowalczyk, R. (2014). NOBANIS – Invasive Alien Species Fact Sheet – *Nyctereutes procyonoides*. – From: Online Database of the European Network on Invasive Alien Species – NOBANIS www.nobanis.org, Date of access 07/05/2015
- Kowalczyk, R., Jędrzejewska, B., Zalewski, A. & Jędrzejewski, W., (2008). Facilitative interactions between the Eurasian badges (Meles meles), the red fox (Vulpes vulpes), and the invasive raccoon dog (Nyctereutes procyonoides) in Bialowieza Primeval Forest, Poland. Canadian Journal of Zoology 86, 1389-1396.
- Kowalczyk, R., Zalewski, A., Jędrzejewska, B., Ansorge, H. & Bunevich, A.N., (2009). Reproduction and mortality of invasive raccoon dogs (Nyctereutes procyonoides) in the Bialowieza Primeval Forest (eastern Poland). Annales Zoologici Fennici 46:291-301.

- Kull, T., Kukk, T., Kull, T., Lilleleht, V and Ojaveer, H. (2001). Võõrliigid Eestis: kes on tulnuktaimed- ja loomad ning mida nendega peale hakata. Keskkonnaministeerium, Tallinn. 23 pp. (In Estonian).
- Laurimaa L, Süld K, Moks E, Valdmann H, Umhang G, Knapp J, Saarma U. (2015). First report of the zoonotic tapeworm Echinococcus multilocularis in raccoon dogs in Estonia, and comparisons with other countries in Europe. Vet Parasitol. 2015 Sep 15;212(3-4):200-5.
- Laurimaa L. Davison J., Plumer L., Süld K., Oja R., Moks E., Keis M., Hindrikson M., Kinkar L., Laurimäe T., Abner J., Remm J., Anijalg P., Saarma U.(2015) Echinococcus multilocularis Tapeworm in Urban Area Estonia. Em. Infect Dis., 21 (1) (2015), pp. 163–164 http://dx.doi.org/10.3201/eid2101.140136
- Lavrov NP. (1971). Results of raccoon dog introductions in different parts of the Soviet Union. Trudy Kafedry Biologii MGZPI 29: 101–160 (In Russian).
- Leger F. & Ruette, S. (2005). Suivi des especes – Le chien viverrin en France. Faune sauvage n°269.
- Léger F. (2008). Situation, en France, de trois petits carnivores introduits: le Raton laveur (*Procyon lotor*), le Vison d'Amérique (*Mustela vison*) et le Chien viverrin (*Nyctereutes procyonoides*).Rev. sci. Bourgogne-Nature - 8-, 178-188
- Lever C. (1985). Naturalized Mammals of the World. New York: Longman.
- Melis C, Herfindal I, Dahl F, Åhlén P-A (2015) Individual and Temporal Variation in Habitat Association of an Alien Carnivore at Its Invasion Front. PLoS ONE 10(3): e0122492. doi:10.1371/ journal.pone.0122492
- Melis C, Herfindal I, Kauhala K, Andersen R, Hogda KA. (2010). Predicting animal performance through climate and plant phenology variables: The case of an omnivore hibernating species in Finland. Mamm. Biol. 75: 151–159.
- Melis C., Nordgård H., Herfindal I., Kauhala K., Åhlen P-A., Strann K.B. & Andersen R. (2007). Raccoon dogs in Norway - Potential expansion rate, distribution area and management implications. NTNU Vitenskapsmuseet Rapp. Zool. Ser. 2007, 3: 1-49.
- Mitchell-Jones A. J., Amori G., Bogdanowicz W., Kryštufek B., Reinjders P. J. H., Spitzenberger F., Stubbe M., Thissen J. B. M., Vohralik V. and Zima J. (ed.) (1999). The Atlas of European Mammals. Academic Press, London, UK
- Mulder J.L. (2011). The raccoon dog in the Netherlands – a risk assessment. Commissioned by Team Invasieve Exoten Ministerie van Economische zaken, Landbouw en Innovatie.
- Mulder, J.L. (2012). A review of the ecology of the raccoon dog (Nyctereutes procyonoides) in Europe. Lutra 55 (2): 101-127.
- Naaber, J. 1974. Rebane ja kährikkoer meie looduses. Jaht ja Ulukid. Eesti NSV Jahimeeste Seltsi aastaraamat 1969-1972. Valgus, Tallinn, 102-115
- Nafi Solaiman Al-Sabi M.,Chriél M.,Hammer Jensen T., Larsen Enemark H. (2013). Endoparasites of the raccoon dog (*Nyctereutes procyonoides*) and the red fox (Vulpes vulpes) in Denmark 2009–2012 – A comparative study .J Parasitol Parasites Wildl. ; 2: 144–151.
- Nentwig W., Kühnel E. and Bacher S. (2010). A Generic Impact-Scoring System Applied to Alien Mammals in Europe. Conservation Biology Volume 24, Issue 1, pages 302–311
- Nordstro¨ma M., Ho¨gmanderb J., Lainec J., Nummelinc J., Laanetud N., Korpima¨kia E.. (2003) Effects of feral mink removal on seabirds, waders and passerines on small islands in the Baltic Sea Biological Conservation 109 359–368

- Novikov GA. (1962). Carnivorous mammals of the fauna of the U.S.S.R. Jerusalem: Isr. Progr. Sci. Transl. 78–85.
- Nowak E, 1984. Development of populations and geographical distribution of the raccoon dog Nyctereutes procyonoides (Gray, 1834) in Europe. Z. Jagdwissenschaft 30: 137–154 (In German)
- Opermanis O, Mednis A, Bauga. (2001). Duck nests and predators: interaction, specialisation and possible management. Wildl. Biol. 7: 87–96.
- Pannwitz, G., Mayer-Scholl, A., Balicka-Ramisz, A. & Nöckler, K. (2010) Increased Prevalence of Trichinella spp., Northeastern Germany, 2008. Emerging Infectious Diseases 16 (6): 936-942.
- Pianka, E.R. (1978). Evolutionary ecology – second edition. Harper and Row, New York, US.
- Puffpaff, S. (2008). Naturschutzfachliche Kartierung und Bewertung der Gewässerstruktur des Nationalparks Jasmund unter Berücksichtigung bestimmter Gewässer als Feuchtlebensräume der Anhang II Arten der Fauna-Flora-Habitat-Richtlinie. Diplomarbeit Hochschule Neubrandenburg.
- Pūraitė I., Griciuvienė L., Paulauskas A., Sruoga A., Gedminas V. (2011). Genetic variability of raccoon dogs and their impacts on the environment in Lithuania 8th European Vertebrate Pest Management Conference.
- Rauel, V. (2011) État des lieux des espèces animales exotiques envahissantes en Champagne-Ardenne. Centre d'Études techniques de l'Équipement (CETE) de l'Est - Département Aménagement et Développement Durable, 72p.
- Rømer A. E., Nørgaard L. S., Götz Mikkelsen D. M., Chriél M., Elmeros M., Bo Madsen A., Pertoldi C. and Hammer Jensen T. (2015). Population viability analysis of feral raccoon dog (*Nyctereutes procyonoides*) in Denmark Arch. Biol. Sci., Belgrade, 67 (1), 111-117
- Rudert S., Brown J.L., Gansloser U., Mobius G. & Songsasen N. (2011). Activity pattern, reproductive behaviors and gonadal hormones in the raccoon dog (*Nyctereutes procyonoides*). Zoo Biol 30: 134–148.
- Schwarz S., Sutor A., Staubach C., Mattis R., Tackmann K., Conraths F.J. (2011) Estimated prevalence of Echinococcus multilocularis in raccoon dogs Nyctereutes procyonoides in northern Brandenburg, Germany. Curr. Zool., 57, pp. 655–661
- Sheldon J. (1992). Wild Dogs: The Natural History of the Nondomestic Canidae . San Diego: Academic Press.
- Sidorovich A.G., Polozow A.G., Lauzhel G.O., Krasko D.A. (2000). Dietary overlap among generalist carnivores in relation to the impact of the introduced raccoon dog Nyctereutes procyonoides on native predators in northern Belarus. Z. Säugetierk. 65: 271–285.
- Singer A., Kauhala K., Holmala K. and Smith G. (2009). Rabies in North Eastern Europe – the threat from invasive raccoon dogs. Journal of Widlife Diseases 45: 1121–1137.
- Stier N. (2006). Rivale von Fuchs und Dachs? Marderhund: Okologische Auswirkungen der Besiedlung. Neuburger auf dem Vormarsch. Sonderheft von Unsere Jagd, Pirsch & Niedersachsischer Jager. 24-29. Berlin, Deutscher Landwirtschaftsverlag Gmbh.
- Sutor A, Kauhala K, Ansorge H. (2010). Diet of the raccoon dog Nyctereutes procyonoides: A canid with an opportunistic foraging strategy. Acta Theriol. 55: 165–176.
- Sutor A, Schwarz S, Conraths FJ (2014) The biological potential of the raccoon dog (Nyctereutes procyonoides, Gray 1834) as an invasive species in Europe—new risks for disease spread. Acta Theriologica 59: 49–59.
- Svenska Jägareförbundet (2015). Årsrapport, Svenska mårdhundsprojektet, Omfattar perioden 2014-01-01 – 2014-12-31.

- Thiess A, Schuster R, Nockler K, Mix H. (2001). Helminth findings in indigenous raccoon dogs Nyctereutes procyonoides (Gray, 1843). Berl. Münch. Tierärzlt. Wschr. 114: 273–276 (In German with English summary).
- Väänänen, V.-M., Nummi, P., Rautiainen, A., Asanti, T., Huolman, I., Mikkola-Roos, M., Nurmi, J., Orava, R. & Rusanen, P. (2007). Vieraspeto kosteikoilla – vaikuttaako supikoira vesilintujen ja kahlaajien poikueiden määrään? Suomen Riista 53:49-63. (with English summary)
- Viro P, Mikkola H. (1981). Food composition of the raccoon dog Nyctereutes procyonoides Gray, 1834 in Finland. Z. Säugetierk. 46: 20–26.
- Ward O. & Wurster-Hill, D. (1989). Ecological studies of Japanese raccoon dogs, *Nyctereutes procyonoides*. Journal of Mammalogy 70: 330-334.
- Westerling, B. (1991). Raivotauti Suomessa ja sen torjunta vuosina 1988-90 [Rabies in Finland and its control 1988–90]. Suomen Riista 37: 93-100. [with English summary]
- Wittenberg R. (ed.) (2005) An inventory of alien species and their threat to biodiversity and economy in Switzerland. CABI Bioscience Switzerland Centre report to the Swiss Agency for Environment, Forests and Landscape.
- Wlodek K. & Krzywinski A. (1986). Zu Biologie und Verhalten des Marderhundes (Nyctereutes procyonoides) in Polen. Zeitschrift fur Jagdwissenschaft 32: 203-215.
- Woloch A, Roženko N. (2007). Acclimatization of the raccoon dog in southern Ukraine. Beiträge zur Jagd-und Wildforschung 32: 409–422 (In German).
- Zoller H., Drygala F. (2013). Activity patterns of the invasive raccoon dog (Nyctereutes procyonoides) in North East Germany. Folia Zoologica, (in press)
- Zoller, H. (2006). Koexistenz zwischen Enok und Reineke. Neubürger auf dem Vormarsch. Sonderheft von Unsere Jagd, Pirsch & Niedersächsischer Jäger. 26. Berlin, Deutscher Landwirtschaftsverlag Gmbh.