Information on measures and related costs in relation to species included on the Union list

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This technical note provides information on the effectiveness of measures, alongside the required effort and resources, used to prevent the introduction, and to undertake early detection, rapid eradication, and management for the invasive alien species under review. Each table represents a separate measure.

Species (scientific name)	*Nyctereutes procyonoides* (Gray, 1834)
Species (common name)	Raccoon dog
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Summary

Highlight of measures that provide the most cost-effective options to prevent the introduction, achieve early detection, rapidly eradicate and manage the species, including significant gaps in information or knowledge to identify cost-effective measures

A major experience with the management of the raccoon dog (*Nyctereutes procyonoides*) in Europe is the North European cooperative management project which takes place in Sweden, Finland, Denmark and Norway. This cross-border-cost sharing-cooperation project has been ongoing since 2010 when the EU-Commission approved a three year LIFE+ project (LIFE09 NAT/SE/000344 "Management of the invasive raccoon dog (Nyctereutes procyonoides) in the north-European countries") to develop methods to address the threat from the invading raccoon dog in Scandinavia (Dahl *et al.*, 2010). The project first started in Sweden and Norway in 2008, but it was soon realized that stopping a highly mobile and reproductive invasive alien species from invading would not be possible if not also the neighboring countries, where the species already was established (in Finland) or at risk to become established (Denmark), got involved (Dahl *et al.*, 2010). Ever since the start in 2008, the Swedish Environmental Protection Agency has been supporting the project financially, together with the Norwegian Environment Agency. The Norwegian Environment Agency also co-financed the LIFE+ project 2010-2013 even though Norway could not benefit from the EU-funding themselves, since they are not an EU-member. Also Danish (Danish Nature Agency) and Finnish (Finnish Wildlife Agency) authorities co-financed the LIFE+ project, and have also since the end of the EU-funding continued funding their respective national efforts in the still ongoing transnational management project.

Still, nine years after the project started (or seven years from the LIFE+ project started), the raccoon dog has not spread further than what was the case back then (Svenska Jägareförbundet, 2017; Finnish Wildlife Agency, 2016). The raccoon dog population is enclosed, and Scandinavia is still largely free from the raccoon dog. The methods developed for managing the raccoon dog are all built on published scientific knowledge, and the projects own applied research, specifically for the situation in the dispersal front of the raccoon dog (e.g. Melis *et al.,* 2015; Herfindal *et al.,* 2016). Far from all the knowledge gained within the project has been published scientifically as yet (Dahl and Åhlén *et al.*, unpublished results).

Most of the measures described below are direct results from the north European cooperative raccoon dog management project and tested practically, while some are more suggestions of measures that may or may not have potential to work but are still untested for the raccoon dog, or in some cases, more wishful thinking of what should be valuable to implement, but could be practically or economically very challenging.

The measures have been described as separate packages, but it should be noted that the professional hunters work simultaneously with all (or most) of the most important measures, making it difficult to give exact assessments of personnel costs. Those measures that are currently used are the ones believed to be the most effective, and should be implemented in any new management effort elsewhere. These are: cooperation with neighboring countries, professional hunters, game cameras, citizen science observation system, genetic species identification, Judas animals, traps, voluntary hunters and hunting dogs. Some measures described may be suitable for use on several levels, i.e. both for early detection and rapid eradication. In such cases the measure has been placed where it is most important, but also related to on the other relevant level(s). For example, Professional hunters are most

important when it comes to eradication, but are also important for rapid eradication and management.

Depending on the goal of the management and the different prerequisites in the countries, different measures work better or worse for each country compared with the others. In Finland for example, which has a strong raccoon dog hunting culture with dogs and traps and a goal to lower the population close to the border to Sweden, significant progress can be made with just one professional hunter supported by many voluntary hunters. Total yearly costs for the management in the different countries are approximately; for Sweden 800,000 Euro, for Norway 110,000 Euro, for Finland 160,000 Euro (whereof part of it from the Norwegian budget) and for Denmark 380,000 Euro, as this is also highly context dependent.

Cost for control/rapid eradication detailed below may be considered high for the management of a single species. However, if the management system is developed in a dynamic way so that it can handle all invasive mammal and bird species in a cross-border-cost sharing cooperation between source and sink countries, the cost for management of a single species will be very low. Several of the tools and methods described below will be applicable for many other invasive alien species (IAS) and there is much to gain in building management systems that work across borders between countries as well as for species.

The framework of measures described in this note is very Nordic specific, both regarding culture (e.g. how local hunting is perceived and accepted) and state of invasion of the raccoon dog. In Scandinavia the raccoon dog has recently invaded and exists in small numbers at the invasion front, which is very different from the situation in central and Eastern parts of EU where the raccoon dog is about everywhere and often in very high numbers, including transboundary regions. Many of the measures are however useful also in areas where the raccoon dog has established. Even if it is not possible to eradicate the raccoon dog with these measures, it can be managed and kept at low(er) densities, especially in vulnerable areas and along borders to countries where it has not yet established. Progress on efficient measures for large scale eradications are made all the time and many successful large scale eradications projects has been conducted around the globe (Simberloff, 2003).

For ease of reading, “raccoon dog” has been abbreviated to “RD” in the running text in the tables.

For the production of this technical note colleagues responsible for, or involved in, the raccoon dog management in the Nordic countries have been consulted, namely:

Lars Trier, Danish Nature Agency, Ministry of Environment and Food, Denmark
Caroline Bald, Danish Environmental Protection Agency, Ministry of Environment and Food, Denmark
Karl-Åge Dalbæk Andersen, Danish Hunters’ Association
Mikko Alhainen, Finnish Wildlife Agency, Finland
Robin Juslin, Government of Åland, Finland
Tommy Arfman, Kimito, Finland
Erik Lund, Norwegian Environment Agency, Norway
Göran Spong, Swedish University of Agricultural Sciences, Sweden

Measures that are discussed are:

Prevention
1. A ban on keeping, importing, selling, breeding and growing raccoon dog (*Nyctereutes procyonoides*) as required under Article 7 of the IAS Regulation
2. Physical barriers
3. Cooperation with neighboring countries

Early detection
1. Game cameras (also important for rapid eradication and Management)
2. Citizen science observation system
3. Genetic species identification
4. Judas animals (also important for Rapid eradication and Management)

Rapid eradication
1. Professional Hunters (also important for Early detection and Management)
2. Hunting dogs (also important for Management)

Management
1. Voluntary Hunters
2. Traps

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Prevention – measures for preventing the species being introduced, intentionally and unintentionally. This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for each of the prevention measures identified.**	
Measure description Provide a description of the measure	**A ban on keeping, importing, selling, breeding and growing raccoon dog (*Nyctereutes procyonoides*) as required under Article 7 of the IAS Regulation** The restrictions under Article 7 of the IAS Regulation will be applicable as of 2 February 2019. Transitional measures for commercial and for non-commercial owners, as well as derogations for

	fur farming are provided for in the Regulation.
Effectiveness of measure e.g. has the measure previously worked, failed	A ban on these activities is required, to prevent the possibility of a constant movement of the species into and between EU Member States. However, a ban will only be effective in practice if it is duly enforced and extensively communicated. Many people who are unaware of IAS and their impacts, and those that keep RDs as pets, would probably obey a ban if they are made aware of the impact of the species in the wild and that it is illegal to release their pets. In Denmark, keeping a RD as a pet was banned in 2011, at the beginning of the LIFE+ raccoon dog project (LIFE09 NAT/SE/000344 "Management of the invasive raccoon dog (*Nyctereutes procyonoides*) in the north-European countries"). All known existing RD pets were sterilized but could be kept for the duration of their lifetime. As far as the authorities can tell, the ban has been successful. However, no one knows if there are people that did not report their pets, or how many are kept illegally today (Caroline Bald, pers. Comm. 2017). People that already understand that a species is an IAS and still chose to import or keep them, either as pets or to release in nature, will probably not comply with a ban, unless there are significant punishments associated with it. Online platforms exist in Europe where it is possible to buy a RD (e.g. www.terraristik.com). It is possible that some platforms will continue these activities also after the introduction of a ban. A recent example of IAS kept illegally can be found in Norway where, despite an existing ban, a person was arrested for illegally keeping 4 RDs, 5 raccoons (*Procyon lotor*) (whereof one had escaped) and 3 ring-tailed coati (*Nasua nasua*), which were discovered while investigating other matters (Erik Lund, pers. comm. 2017). A raccoon was also culled in nature in central Sweden during the summer of 2013. The animal was with high certainty an escapee from an illegal private owner. The female raccoon had, according to the autopsy, given birth to 5 pups earlier that year, but no more raccoons could be found in the area despite intensive efforts. It is highly unlikely the raccoon had dispersed from Germany or mainland Denmark, through the islands of Denmark and up through a third of Sweden. Horizontal scanning for IAS by following different Facebook groups on RD as pets (e.g. Raccoon Dog Society, The British Raccoon Dog Society) will also show that RD,s kept as pets in the UK are escaping regularly. UK probably already has a founder population of RD.
Effort required e.g. period of time over which measure need to be applied to have results	The ban needs to be indefinite.

Resources required [1] e.g. cost, staff, equipment etc.	Administrative costs of implementing the ban and costs for enforcing the ban including involvement of police and justice. Costs for communication, in addition to information on the authorities home pages included in the administrative implementation. There will need to be intensive information communicated, for example in newspapers, radio and television to reach those (the major part of the public) who do not regularly update themselves on the authorities pages. This is however relatively cheap, since media outlets are often very willing to report on issues that pose a threat to nature. Apart from the implementation of the ban and the updates on the authorities home pages communication costs and horizontal scanning on social media probably only comes down to less than one month work per year.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	An effective ban will be positive for public health (RD is the main vector of rabies and an important vector of *eccinococcus multilocularis* (EM) in Europe), ecosystem services (such as berry picking if there is a risk for deadly infection, such as EM, spread by the RD on the berries) and native species (predation on eggs and amphibians) in the long run (Sutor *et al*. 2014). A negative side of a ban may be that people already keeping RDs as pets, will rather release them into the wild rather than euthanize or sterilize them. This may in turn lead to wild local populations that would not have emerged without the ban. In addition, professional breeders, e.g. fur farmers, may be affected economically if either the ban is total so they have to shut down, or they have to pay for costly additional precautions not to let them escape and individual markings of the animals. Farmed RDs have recently been shown useful as Judas animals (RDs with transmitters) in the wild, to find wild animals (see table below on Judas animals) (Dahl and Åhlén *et al.*, unpublished results). A total ban on fur farming would take this opportunity to get hold of very cheap Judas animals away.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	In general the acceptability of a ban by the public is probably high. Most people would not be affected by the ban and it will help reduce current and prevent future impacts to native biodiversity and related ecosystem services. Professional fur farmers are negative. Communication by the competent authorities on the transitional provisions for pet owners will be necessary.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction	The cost for fur farms to comply with the requirements for a permit under Article 8 of the IAS Regulation would vary and could be significant depending on their current infrastructure for mitigation measures to reduce the risk of escape. Even though it would be illegal to import and keep RD as pets, it is likely people would still try to

- the cost-effectiveness - the socio-economic aspects	smuggle them in. As an addition to a ban, it would be very positive if an intensified customs control was also applied not only on the outer borders, but also within the EU (Genovesi and Shine, 2004). If the controls are 100 % successful, it would end all illegal import/export of RDs within the EU which may not be the case with only a ban as described in the Norwegian case above. The framework already long-exists for CITES and just needs be extended for IAS. This will not be for free of course. But controls are carried out anyway, so It is largely about also paying attention to non-CITES species. It would be naïve to believe that no CITES animals or parts of animals are smuggled in to countries today, but such a system for IAS also would still be better than no system at all.
Level of confidence [2] See guidance section	Medium. Bans on keeping different biological taxa, for example reptiles, as pets have been in place in Norway for many years only resulting in that Norway recently had to take away the ban due to the fact that the herpetological hobby increased strongly over the years showing that a ban is far from functional if the general public don´t agree on the importance of the legislation. On the other hand, Sweden has since long time a ban for primates and mammalian predators as pets that is working quite well if not 100%. The general public probably agrees that primates and different mammalian predators are not well adapted for the life as a pet and thereby follow the legislation. To increase public awareness on the threats towards biodiversity that our environment is facing with IAS is probably a very important tool to make the legislation understandable.

Prevention – measures for preventing the species being introduced, intentionally and unintentionally. This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for each of the prevention measures identified.**	
Measure description Provide a description of the measure	**Physical barriers** Theoretically it should be possible to stop or steer RDs with physical barriers, similarly to what has been applied to other canine species. In particular electrical fencing that has been used for the red fox (*Vulpes vulpes*) (Forster, 1975; Minsky, 1980; Mayer and Ryan, 1991). The world's longest fence (5,614 kilometres) is the "Dingo Fence" in Australia, built to restrict the dispersal and movement of dingoes (Pople *et al.,* 2000). It has proven to be effective to exclude the target species from the most intensive sheep areas. It is likely that only a few low electric threads alongside cross European highways, outside of the distribution areas, would be needed to make a serious dispersal obstacle also for dispersing RDs. However, no evidence can be found that this method has been tested on RDs**.**
Effectiveness of measure e.g. has the measure previously worked, failed	No information is available on the application of this measure on RD, but it could be very cost

	effective. If being steered along the fence to find a passage, the fence together with a few game cameras and/or traps at the ends can effectively cover many miles of area, which would otherwise need much more manpower as well as costly tools.
Effort required e.g. period of time over which measure need to be applied to have results	There would need to be long term maintenance to keep the fence functional.
Resources required [1] e.g. cost, staff, equipment etc.	The cost of putting up the fence and to manage it afterwards. In a LIFE-bid 2014 the probable cost for erecting a electrical fence alongside the 60km Danish - German border resulting in a major migration obstacle for RD,s and raccoon's dispersing northbound from Germany was calculated to €5/meter for the fence and one full time personnel per 60km fence during the vegetation time to cut grass under the fence for the yearly management. If fences are erected alongside highways with no growing grass the maintenance cost would be extremely much lower. A cost sharing angle would also take down the "species cost" as an electrical fence would also steer other invasive species such as Raccoons, Coati, Mongoose, Skunks and different squirrel species to unfenced sections were surveillance and rapid control will be facilitated by the narrowed dispersal sections.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	The impacts to non-target species could be significant, as the movement of other species would be affected by the fence. Wild boars are very sensitive towards electrical fences and their movements will probably be very restricted by the fence and it can also be used to manage the threat from the African Swine Fewer.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Possibly low since it could at least mentally restrict the public's access (in practice the fence would be very low and no problem to step over) and could potentially harm pets such as dogs. But if erected alongside already existing man-made structures such as highways the acceptability to stakeholders should be high. Other non-target threatened, species (lynx, wolves, brown bears, otters to name a few) will also be steered away from highways by an electrical fence resulting in a major decrease in traffic mortality which will be highly acceptable among stakeholders. Ungulate movement (especially wild boars) over high ways will also be seriously affected by an electrical fence resulting in decreasing numbers of potential human casualties with wild boar accidents.
Additional cost information [1] When not already included above, or in the species Risk	While there is no information on costs for this measure, however it is believed that it could be very cost effective.

Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	To be able to focus early detection and rapid eradication activities to the unfenced sections should be very cost effective. By taking an conservation cost sharing angle on this, the decrease in traffic mortality for threatened species should be considered
Level of confidence [2] See guidance section	Low. No experience or information is available on the application of this measure on RD, but it could be very cost effective since it is working on similar species.

Prevention – measures for preventing the species being introduced, intentionally and unintentionally. This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for each of the prevention measures identified.**	
Measure description Provide a description of the measure	**Cooperation with neighboring countries** For a highly mobile species, such as the RD, it is absolutely necessary to develop transnational cooperation with neighboring countries in which the species is already well established, in order to stop, or at least lower, the expansion of the species (e.g. Genovesi and Shine, 2004; Shine *et al.,* 2009). The effort needed to eradicate a highly reproductive and fast dispersing immigrating species at the own country border, if it is allowed to develop freely on the other side of the border, is probably overwhelming. In the Nordic cooperative RD project, currently moving in to its ninth year (part of which 2010-2013 was financed by EU through the LIFE09 NAT/SE/000344 "Management of the invasive Raccoon Dog (*Nyctereutes procyonoides*)), Norway has always been involved in the project even though they have only had occasional confirmations of RD presence. Norway has, from the beginning, funded parts of the project in the neighboring countries as it helps keep Norway free from the RD. At the time of writing Norway is funding a large part of the Finnish management actions at the border towards northern Sweden and Norway since Finland could not cover the funding needs themselves (Finnish Wildlife Agency, 2016; Erik Lund, pers. comm. 2017).
Effectiveness of measure e.g. has the measure previously worked, failed	Nine years after the project started, Norway still does not have an established population of RD. In fact, the confirmed RD records in most recent years are fewer than at the beginning of the project nine years ago (Directorate for Nature Management, 2008). In the previous three years only one RD

	sighting has been confirmed annually (Erik Lund, pers. comm. 2017). During the same time more than 500 RDs have been culled in northern Sweden and more than 1,100 in northern Finland (Finnish Wildlife Agency, 2016; Svenska Jägareförbundet, 2017). The effectiveness depends upon the management success within neighboring countries. The Norwegian example may also be a best case scenario since the northern latitude keeps the population density at a low level compared with most of central Europe, and the land features are favourable for restricting range expansion with high mountains on a large part of the border. However, the length of the border protected against RD immigration into Norway from Finland and Sweden is well over 1,000 km.
Effort required e.g. period of time over which measure need to be applied to have results	Very little effort required by the RD free countries. It is highly recommended to keep generally updated about the situation in the other countries and to participate in transnational management meetings to be involved in and able to affect how the contributed funding is spent in the neighboring countries. The effort have to be continuous or until the neighboring countries have eradicated the RD.
Resources required [1] e.g. cost, staff, equipment etc.	Norway today contributes approximately 80,000 (of 160,000) Euro/year to the Finnish management plan. Apart from this they have an approximate cost for preparedness of early detection and rapid eradication, in the case a RD gets into the country, of about 30,000 Euro/year (Erik Lund, pers. comm. 2017). This can be compared with the cost for the Swedish management of 820,000 Euro annually. If the RD established in Norway it is reasonable that the cost would be similar for Norway as for Sweden, approximately 800,000 Euro/year.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Neighboring countries, with an existing RD population, may be more encouraged to run an effective management program if partly funded by another country.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The transnational cooperation is acceptable to all stakeholders.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness	To be proactive and offer to help to fund neighboring countries management is probably the most cost efficient measure a country still free from the RD or other IAS can do. The cost of inaction (the case for Norway-Sweden) is discussed above.

- the socio-economic aspects	
Level of confidence [2] See guidance section	High. The cross-border-cost sharing cooperation between source and sink countries in the Nordic countries have proven to be very effective for the management of the invasive RD. Experience from the Nordic RD project and expert opinions from respective country confirms the level of confidence especially regarding the RD.

Early detection - Measures to achieve early detection and run an effective surveillance system for achieving an early detection of a new occurrence (cf. Article 16 of the IAS Regulation). This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for each of the early detection measures identified.**	
Measure description Provide a description of the surveillance method	**Game cameras** Game cameras with a multimedia messaging (MMS) function, which send pictures to a recipient via MMS or e-mail, are set up directed towards a bait or a scent lure (or sometimes to where the RD is expected to show itself). Once the camera records a RD, it is important to get to the location fast to capture the animal, preferably by using a hunting dog (see rapid eradication below). There are several different ways the game cameras can be used for RD: a. As an early warning system (EWS) to alert when a new individual has entered the country or a new region in the country. RDs are highly monogamous. If they find a partner they will take on a home range which they will have total control over. The size of the home range varies depending on recourses and time of year. In southern Finland a home range is around 700-1,000 ha throughout the year, in northern Sweden it is about 2,200 ha (Kauhla, *et al*. 1993, Dahl *et al.,* 2012). Any new scent markings from conspecifics or other predators within the home range are explored and marked over by the resident individuals (Dahl and Åhlén *et al.*, unpublished results). By placing cameras against scent gland lures, from a RD or similar species, with a distance between them that will ensure that every possible home range has at least one camera set in it, it is very likely that any stationary RDs (pairs) will sooner or later show themselves (Dahl and Åhlén *et al.*, unpublished results). Single RDs do not have the same restricted home ranges as pairs. Single RDs usually roam large areas in search of a partner and may easily miss cameras while passing the area of an early warning system. It is

	recommended that the EWS is quite wide, that is, not just one single row of cameras along a border, but maybe also five home ranges wide. Some single animals will then also pass close enough to sense any of the lures and will then investigate it. If the system is wide, the chance of finding also single animals increases (Dahl and Åhlén *et al.*, unpublished results). b. On existing baits for other game species. If there already exist baits managed by hunters for wild game species, for example for wild boar or red fox, it is advantageous to also put cameras on those baits in cooperation with the hunters. The RD is an omnivore with a wide food preference and very opportunistic when it comes to food (Kauhala, 2009). Especially in winter and spring, when the food is scarce, RDs often utilize baits. Cameras on existing baits can be used all over the management area to lower the population, or only in the EWS area. Today most land areas outside of cities and protected conservation areas in Europe are used for hunting and most hunters or hunting teams will own at least one game camera to keep track of their game populations or to identify what time the game will show themselves on baits and other attractive areas. For example, in Sweden there are thousands of game cameras sold per year (Dahl and Åhlén *et al.*, unpublished results). If all, or even a fraction of hunters are encouraged to send in pictures of animals from a list of IAS that is communicated to them to the managing authority it would be a very cost-effective European early warning system for invasive alien species in general. An example of this successfully leading to the capture of a raccoon (*Procyon lotor*) is from Sweden in 2013, where a hunter received a photo of a raccoon from his game camera on a wild boar bait. He then contacted the RD project and one week later the animal was captured in a trap (Olsson, 2013). This is the most recent living raccoon that has been captured in Sweden, and was most likely an escapee illegal pet. c. On baits or lures designed for the RD. Cameras can also be used on bait stations especially constructed for RD (usually fish) to manage the species in areas where it is already established or on lures or baits used to find and cull animals observed by the public via citizen science systems (Dahl and Åhlén *et al.*, unpublished results).
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	Game cameras have been very effective for the RD management project in Sweden, where 40-50 % of all captures are made due to cameras managed by professional hunters (Svenska Jägareförbundet, 2017). According to the professional hunters only a small fraction, around 10 %, would have been captured without the MMS-cameras, and they would have required time consuming active hunting. The cameras, however, require that you can capture the animal once its presence is confirmed by the camera. The most efficient way of doing this is with hunting dogs trained to capture RD (see rapid eradication). The dog will track the fresh scent and put the RD at

	bay, often quite some distance from the camera (Dahl and Åhlén *et al.*, unpublished results). Hunting dogs are also frequently and successfully used in traditional hunting (searching with no cameras) in Finland. However, to improve efficiency, especially in vulnerable areas where the RD can lead to significant damage, several cooperative projects between authorities and voluntary hunters have started using the MMS-camera-hunting dog technique with promising results (Finlands Viltcentral, 2016; Ålands Landskapsregering, 2017; Yle, 2017). Hunters receive MMS cameras for free from the authorities and put them on baits. Instead of hunting randomly for RD, or releasing the dog on a snow track found in the forest or by a bait the next day (a usual way to hunt if you do not have a camera, but then the track may be ten hours old), they are able to release the dog on a fresh track just minutes after the RD has been there. The described technique has over 90 % success rate in Sweden and Finland (Tommy Arfman, pers. comm. 2017). In one of the projects the capture doubled from 20 to 40 RDs annually per 1,000 ha (Tommy Arfman, pers. comm. 2017). Other means to capture the confirmed RD is with traps or by sitting in a stand next to the bait to shoot the animal. These two options often work if the RD is stationary and will come back, but usually takes a lot of time. In Denmark the MMS cameras have been identified as a key element in the RD project. The cameras are used mainly for surveilling traps (according to Danish legislation, a set trap has to be checked twice a day and it is legal to use a MMS-camera to this) and testing new spots where RD are reported by making a "bait-place" and/or using scent attractor (Lars Trier, pers. comm. 2017). The camera traps used as an early warning system in northern Sweden are efficient in locating established couples, and are also used to provide an objective measure of the population status. The same places and lure attractant is used every year (i.e. same effort). However, it is less clear how efficient the system is for single animals. Some animals probably walk through the system without coming near enough to smell the lure and be captured by the cameras. As a complement, to increase the chance of finding single animals in the EWS, Judas animals may be kept continuously in the same area (Dahl and Åhlén *et al.*, unpublished results). In total there are about 80-100 cameras in the Swedish system close to the Finnish border in northern Sweden (Svenska Jägareförbundet, 2017).
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	Cameras are used continuously all year around in Sweden, Finland and Denmark. In winter they are used less frequently in the north since most RDs there have winter rest (Kauhala and Kowalczyk, 2011). Cameras are managed mainly by employed professional hunters but also by trained hunters.

	Both professional hunters and hunting dogs are necessary to fully take advantage of the game cameras potential, since once there is an early warning the animal also has to be captured. These measures are fully described in rapid eradication.
Resources required [1] e.g. cost, staff, equipment etc.	Sweden uses 6 professional hunters and 300 game cameras continuously for both the EWS and the management with cameras. The professional hunters are, however, not working full time with the cameras.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	Dogs can sometimes take on tracks from other non-target species that has recently been visiting the bait, such as badgers and brown bears. To avoid any damages to non-target animals the employed personnel have to use muzzles on the dogs. Once the bayed animal is confirmed as other species, the dog is taken away. In areas where there are many owners of small pieces of land it may be difficult to apply the system with dogs in full if every land owner has to be contacted to get permission to hunt. A positive side effect is that not only RD but also other invasive alien species can be detected and hopefully captured with the help of RD cameras and trained hunting dogs (Dahl and Åhlén *et al.*, unpublished results). Game cameras are in demand and do get stolen if not carefully masked. The proportion that get stolen is depending on the number of people that will see them and thereby probably to the human population density.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Game cameras may threaten people's integrity (if they are placed on land where the public has access and thereby can be photographed without knowledge), and thereby be negative. Occasionally animal rights groups oppose the hunting with dogs.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	An early detection camera system of 100 cameras covering 1,000,000 ha will, apart from the cost of the cameras, batteries, subscription cost of sending MMS and lures (approx. 300-500 Euro in total per camera) need about two months working time per year to manage the system. Cameras normally last about five years, but 10-30 % will have to be replaced each year due to failures of cameras or stolen cameras. A full scale professional system for an early detection system + rapid eradication (with employed professional hunters as base and voluntary hunters involved), will need approximately one full time

	salary + 100 cameras per 500,000 – 2,000,000 ha of managed area, depending on immigration rate and the number of voluntary hunters involved. A management system to manage the population in vulnerable areas with the help of voluntary and dedicated hunters in those areas will mainly include the price of cameras and a part time administrator at the responsible authority. In Åland, Finland the cost of their planned system over 55,000 ha is estimated at 20,000 Euro to set up, and after that annual complementary costs for broken/stolen cameras and running costs for batteries, lures e.t.c. (Robin Juslin, pers. comm. 2017).
Level of confidence [2] See guidance section	High. game cameras are in vast use for many eradication as well as normal game management project across the globe. The reduction in labor cost alone for trap checking is increasing the cost effectiveness of trapping projects. The combined use of MMS-cameras and specially trained dogs has over a few years heavily increased the effectiveness for the trans national RD project in the Nordic countries. Experience from the Nordic RD project and expert opinions from respective country confirms the level of confidence especially regarding the RD.

Early detection - Measures to achieve early detection and run an effective surveillance system for achieving an early detection of a new occurrence (cf. Article 16 of the IAS Regulation). This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for each of the early detection measures identified.**	
Measure description Provide a description of the surveillance method	**Citizen science observation system** The public is encouraged to report sightings of RDs to the RD project in Sweden and Denmark. This system works best with an active media strategy, so that as many people as possible know about the RD being an IAS, why it is being an IAS, and that they should report when they have seen one so that it can be captured. In Sweden the governmental agencies send public reports coming to them on to the RD project so that all reports are gathered in one database. In Sweden, between 600 – 1,000 reports come in every year, and they are distributed evenly from all over the country even though the RD is only confirmed in the north (Svenska Jägareförbundet, 2017). Also, reports from the public increase in the days following media coverage (LIFE09 NAT/SE/000344 "Management of the invasive Raccoon Dog (*Nyctereutes procyonoides*) in the north-European countries"). It is crucial to confirm all of the public reports, and it has to be 100 % certain that the reported animal is a RD before it can be officially confirmed by the project staff. Results show that most reports are not RD. Many of the reports can be dismissed with a telephone call, others require more effort to confirm

	the record, this can include visiting the place, using cameras, DNA, searching for tracks. In Sweden the professional hunters in the project do most of the field visits, but also additional trained hunters, paid by the hour, are used as Sweden is a large country and the northern based personnel cannot drive 1,500 km to make a field visit (Svenska Jägareförbundet, 2017). Out of 633 public observations reported to the project in 2016 (616 on RD and 17 on raccoon), 373 could neither be confirmed nor dismissed (Svenska Jägareförbundet, 2017). Only 27 of the reports could be confirmed as RDs, all within the previously confirmed distribution area in northern Sweden (Svenska Jägareförbundet, 2017). In 260 cases the reports could be dismissed as other species, mainly red foxes and badgers, but also more uncommon species such as otter, wolverine and lynx. Quite a few were also common species, such as cats, hares, dogs, minks etc., which shows the very limited knowledge most people have about mammalian species (Svenska Jägareförbundet, 2017). Once confirmed, attempts are made to capture the RDs with the help of dogs or traps. In 2016 RDs were captured or culled on 24 out of the 27 places where they were confirmed, following citizens reports.
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	The citizen science observation system in Sweden is very important. In fact more than 50 % of the captured or culled animals in Sweden 2016 originated from a public observation. Some were observed and directly shot by hunters (which then reported it), some were found as road kills by a public citizen and some were captured by the field personnel after being observed by a public citizen that reported it to the project. Even though very few observations (27 out of 616 RD observations in 2016) end up being a positive identification of RD, the system is still considered very effective since 24 out of totally 40 RDs culled or captured in 2016 originated from the citizen science system (Svenska Jägareförbundet, 2017). It is probable that if a RD disperse outside the current distribution area and get detected, it will be by the citizen science system. The only confirmed live raccoon (*Procyon lotor*) in Sweden since 2008 was for example detected by a local hunter on his game camera and reported to the system in 2013, and captured by the project, in central Sweden (see also Game cameras table above). A system like this is effective in countries with few, or no, RDs. It is not used in Finland since they have enormous numbers of RD, it would be like asking people in continental Europe to report red fox. Although, asking them to report common alien species, though providing little scientific or management advantage directly, may be very valuable in the long-term for raising awareness on biological invasions in general.
Effort required	The Swedish citizen science observation system is quite labor intense. It was necessary to employ a

e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	person (not full time, this person also work with other issues, but maybe 40 %) that administrates the system, keep contact with the observers and manage the actions. Six field managers and about 30 trained hunters are then accessible to confirm reports and capture the animals. An active media strategy also means that media often visit the project.
Resources required [1] e.g. cost, staff, equipment etc.	In all, probably between one and two full time employees are dedicated for the citizen science observation system and related captures in Sweden. The system, however, also already takes care of raccoons (*Procyon lotor*) today, and would with very little extra resources also be able to take care of other IAS. There is also a need for equipment such as cameras, traps and dogs, but which is also used in the other work.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	There are very few negative side effects that have been noticed in Sweden. It was expected that animal rights organisations would oppose but which has only happened occasionally. On the positive side however there are several. For one, most Swedish citizens have due to the related intensive information in media heard about the RD and know it is an invasive alien species, which may also be the reason for the low opposition (Dahl and Åhlén *et al.*, unpublished results). The Nordic countries are however very positive towards hunting and the situation may have been different in other European countries. Once the system is established it is also easy to add other species to report, such as in the case of the raccoon mentioned above, which makes the system more cost efficient (Dahl and Åhlén *et al.*, unpublished results).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The system is acceptable to all stakeholder groups.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	See above.
Level of confidence [2] See guidance section	High. Experience from the Nordic RD project and expert opinions from respective country confirms the level of confidence especially regarding the RD.

Early detection - Measures to achieve early detection and run an effective surveillance system for achieving an early detection of a new occurrence (cf. Article 16 of the IAS Regulation). This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for each of the early detection measures identified.**	
Measure description Provide a description of the surveillance method	**Genetic species identification** Sometimes it is almost impossible to confirm or dismiss an RD observation made by the public. Without additional evidence the observers' words are not enough on their own to confirm a RD sighting as the public are often incorrect when identifying the species (Svenska Jägareförbundet, 2017). If tracking conditions are good or the animal is still present in the neighborhood, tracks or cameras are effective means to confirm or dismiss observations, though some observations have to be left as inconclusive. If, however, DNA can be secured from the animal it is possible to conclude what species it is. The Swedish RD project has commissioned SLU (Molecular Ecology Group, Umeå) to run DNA diagnostics on biological samples of unknown origin. The test uses generic primers that amplify the COX region on the mitochondria and thus can identify all mammalian predators (including IAS such as RD) but also any other animals for which there is a published reference (Göran Spong, pers. comm. 2017). It is essential that the genetic species identification (GSI) uses enough (and species specific) markers to distinguish between species. The RD is a canid, and as such shares many markers with other canids. If the tool is not species specific there will be many erroneous positive matches e.g. from domestic dogs or foxes.
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	It is not always possible to obtain a DNA sample from an animal that has been seen. Even when DNA has been collected, there can be DNA from several different species in a sample which may make it impossible to analyze. For example, one animal may have eaten another so that DNA from both is present in the feaces. In addition, the DNA sample could be contaminated or ruined during handling and thereby made useless, or contain no DNA, such as hair without a root. Within the Swedish RD project observers are encouraged to try to find and sample DNA if possible, for example feaces or hair. If it is not possible to confirm or dismiss the observation directly with other means, the DNA is analyzed. Most analyzed DNA samples so far has shown to be other species than RD. Even though only a few samples have been collected (about 3 % of all observations) and no new RD have been detected by the GSI, it is still an important tool. Instead of putting down months of work pursuing an observation with baits and cameras, it can be dismissed as another species within days with GSI. Out

	of 41 analyzed DNA samples in Sweden 2011-2015, 33 have been dismissed as another species (mainly foxes, badgers or domestic cats), 4 have been inconclusive due to double DNA and 2 have contained no DNA. Two of the samples correctly identified RD, but these were put in as blind tests by the project (from already captured RD) to test the reliability of the GSI. While the Swedish genetic approach is able to distinguish between many animals, the drawback is that it cannot handle DNA from several species in the same sample (double DNA), however other analyses (more expensive) can do this and for example can identify if RD is of the species that have been feeding upon a carcass. By changing analysis method and intensifying the sampling of DNA a more elaborate surveillance system can easily be constructed. For example by systematically sampling DNA from all scavenged carcasses found in the dispersal front each year. In addition, e-DNA (environmental DNA e.g. water samples collected from rivers which raccoon dogs may have visited further upstream) can potentially become an effective monitoring tool for confirming new occurrence in an area, where actions to eradicate the IAS can be put in afterwards. Although such a fine tuned tool is still to be constructed.
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	Today the GSI in Sweden is only used passively and not as a full scale systematic surveillance system. When a suspected RD DNA sample have been found by public observers, or by the project staff, it is preserved and analyzed. The effort required with this setup is very small, ensuring that the sample gets to the DNA-lab. If the sample is sent to the lab immediately, a result can be obtained within a day or two. Normally however, several samples are gathered before starting the analysis to lower the cost. If several weeks have already passed before the observation is reported to the project, speed of the further procedures is not crucial. If a potential RD was a single individual, it will by then have dispersed, in search of a partner. It is, however, still important to find out if it actually was a RD or not, especially outside the known distribution area. If the RD had a partner at the time of the observation, they will still be in the neighbourhood since once two RD's find each other they immediately settle down in the area (Dahl and Åhlén *et al.*, unpublished results).
Resources required [1] e.g. cost, staff, equipment etc.	As stated above, staff costs except laboratory personnel are negligible with the described setup. Equipment needed is sterile sample tubes, alcohol and prepaid envelopes for DNA samples to be sent for laboratory examination. This is usually done after an observer has been contacted and the observation cannot be easily dismissed on other grounds, and there is potential to find DNA from the observed animal. Instructions how to best gather the DNA-sample is given at the same time. Costs for DNA analyses are depending on the number of samples to be analyzed. If a quick answer is

	necessary, and a single sample is analyzed, the cost in the Swedish system is about 400 Euro. With a 'full row' (8 samples) the cost per sample reduces to 80 Euro, and for a 'full tray' of 24 samples the cost comes down to 50 Euro per sample. The analysis costs may of course differ between countries and labs. For the systematic sampling approach described above the sampling effort and cost would increase significantly if professional personnel are used, less if sampling is done voluntarily, but this would probably negatively affect the sampling intensity instead. The costs for DNA analyses that can handle double DNA are likely to be higher.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	No negative side effects have been noticed in Sweden. The method is totally non-invasive. On the positive side it is enlightening to get confirmation of the species even though it was not a RD. If developed for all potential new IAS, the tool will be useful for more than one IAS species.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The system is acceptable to all stakeholder groups.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	See above.
Level of confidence [2] See guidance section	High. Experience from the Swedish RD project confirms the level of confidence.

Early detection - Measures to achieve early detection and run an effective surveillance system for achieving an early detection of a new occurrence (cf. Article 16 of the IAS Regulation). This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for**

each of the early detection measures identified.	
Measure description Provide a description of the surveillance method	**Judas animals** Some species are social by nature, searching for and pair up with conspecifics if they become alone. This natural behavior can been used to find new animals by letting one animal (the Judas animal) disclose others, by tracking the Judas animal. The Judas technique has proved to be a very effective conservation tool for social animals such as goats to find conspecifics when there are very few animals left to find (Campbell and Donlan, 2005). The RD is monogamous and lives in life long pairs. If one of the partners dies the other one will start searching for a new partner. Juveniles will also start searching for a partner when they reach sexual maturity (Kauhala and Kowalczyk, 2011; Dahl and Åhlén *et al.*, unpublished results). This social behavior is used for management purposes in the Nordic countries, where instead of culling all RDs, some are captured with baying dogs or traps and used to find new RDs. These captured RDs (Judas animals) are treated against parasites and fitted with collars having GSM or satellite transmitters to be able to track their movements continuously. Normally they are also sterilized before they are released to avoid unwanted reproduction if the transmitter fails (Herfindal *et al.*, 2016). It is important to notice that the animals are sterilized, not neutered, so that they still have their libido intact to search for a partner. A single animal will normally move quite long distances (5-10 km) per day (Herfindal *et al.*, 2016). Once the transmitter-fitted animal stops for several days within a limited area (100-2,000 ha depending on the habitat) it is located in the field to see if it has a new partner. If pairing is confirmed, the new partner is either culled or captured and kept as a new Judas animal according to above, and the original Judas animal is once again released on its own. Both sexes work equally well as Judas animals. Judas animals can either be free to move where they want, usually released on the place where they were initially captured to see if they already had a partner, or they can be moved to areas where it is believed that there is a RD that has not been captured. For example, where a hunter has shot a RD, but did not see any partner or was not able to shoot it. For similar occasions, when one RD has been captured, it can be temporarily released with a transmitter but without sterilization to find its partner (Lars Trier, pers. comm. 2017). Sterilization usually takes at least a week before the RD can be released again, and by then the partner can have moved on.
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	Judas animals are most effective when deployed in low density populations. In high density populations most or all Judas animals will soon find a partner, they will get “trap saturated”. At high population densities a lot of work is required to capture new partners and move Judas animals; efficiency is relatively small under such circumstances. If efficient alternative

	methods are limited, the captures due to the Judas animals can however make up a large proportion of all captured animals, although it will have little effect on the population as a whole. Using solely Judas animals is in practice not sufficient to stop the population from increasing once it has reached above a certain threshold level (Dahl and Åhlén *et al.*, unpublished results). At medium densities Judas animals will find some new partners. Some of these new animals will be animals that would have been hard to catch otherwise. In general though, using Judas animals will have limited effect on a medium sized population. If alternative measures are reasonably effective, a rather small proportion of all captured animals will be captured by Judas animals. This is the current situation today in Sweden, the population is declining due to an efficient camera-hunting dog system, but has not yet reached so low level that Judas animals have taken over as the most important measure (Dahl and Åhlén *et al.*, unpublished results). At low population densities, Judas animals will have larger effect on the population and make up a larger proportion of all captured animals. It is almost impossible to find a RD in almost unlimited areas with a hunting dog, with traps or with cameras. Judas animals on the other hand will walk approximately 10 km per day, all year around (except mid-winter in the north), in search of a partner (Herfindal *et al.,* 2016). If they cross a RD track from a single animal of the opposite sex, they will most likely find the other RD. Judas animals may also disclose pairs by stopping in an area, probably trying to take over the partner, but then moving on when failing (Lars Trier, pers. comm. 2017). Temporary Judas animals can be very effective, for example when a pup has been captured, to find other pups or the parents (Dahl and Åhlén *et al.*, unpublished results). For pups much smaller transmitters are used than for adults. The Judas animal method is most efficient at very low densities. When only few animals are left in a population up for eradication, the Judas animals will probably be the only way of finding them all. Similarly, as an early warning in countries that do not yet have the RD it is, based on the experience in Sweden, effective to detect them with Judas animals. The first and so far only known wild RD outside mainland Denmark was found by an early warning Judas animal (Lars Trier, pers. comm. 2017). By having several Judas animals of both sexes in an area it will also be possible to assess the risk that new animals are present. As long as the Judas animals only find each other it is a low risk there would be other animals around. All Judas animals pairing up with each other must be

	immediately separated to ensure the efficiency of the system. In Sweden some Judas animals have been found to be very efficient while others have never paired up with a new mate. It is likely that there are individual differences in how efficient the animals are. Ineffective animals should, if possible, be replaced with new animals. In Sweden the RD population has decreased heavily over the last years due to efficient management (Svenska Jägareförbundet, 2017). Even though it is not extremely low yet, the managers can foresee that there will be difficulties to find new Judas animals in a few years. Trials have therefore been initiated to release farmed RDs from Finnish fur farms as Judas animals to find out if they survive in nature and if they are as efficient in finding new animals as wild Judas animals (Svenska Jägareförbundet, 2017). Out of 20 farmed animals released in May 2016 almost all were still alive after two months. At the end of the year still very few had died naturally, and they found as many partners as did the wild animals (Dahl and Åhlén, unpublished data). Farmed RDs may also be an easy and cheap way to set up an early warning system for countries that do not yet have RDs in their countries.
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	As they are most effective at very low densities, Judas animals should be captured before the population gets too low to find them. Alternatively, Judas animals can be bought from RD fur farms, if such farms are still allowed to operate. Judas animals are most effective during spring and autumn when RDs usually pair up. But it has been found that RDs move and search for mates all year around (Herfindal *et al.,* 2016). It is challenging to find and capture new RDs so it is recommended to keep the Judas animals all year around until they die naturally.
Resources required [1] e.g. cost, staff, equipment etc.	One full time employee will manage about 20-25 Judas animals. Depending on the size of the management area, a minimum of ten Judas animals should always be active, preferably with an equal sex ratio since both sexes are equally likely to disperse into new areas (Herfindal *et al.,* 2016). Judas animals pairing up with each other should be immediately separated to keep the system as efficient as possible. One GSM/Satellite collar costs approximately 2,000-2,500 Euros. Depending on the settings of the positioning the battery will last between 6 months to one year. A battery replacement will cost approximately 500 Euros. A collar can last up to five years if not physically damaged. Operator costs for GSM traffic may have to be added. In total, considering that collars are able to work for five years, the cost of collars will be between 1,000-1,500 Euros per collar/year. Triangulation equipment for locating the transmitter signal in the field costs about 1,000 Euros per unit. Capturing of animals is included in the cost of the full time employee.

	Sterilization will cost approximately 200 Euro per animal. Additional costs include a place to keep RDs captured while waiting for sterilization, etc.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	Judas animals are routinely sterilized to avoid unwanted reproduction if the transmitter fails. Temporary un-sterilized Judas animals can be very effective, for example to find a partner, but they may also pose a risk since they are still fertile. All Judas animals pairing up with each other must be immediately separated to ensure the efficiency of the system. Since both sexes disperse and search for partners equally efficient it is however important to also have Judas animals of both sexes. It will mean more work to capture and separate them, but will also give an indication of how large proportion of the total population is made up by Judas animals and by "wild" immigrating animals, i.e. a rough capture-recapture estimate. Solely capture-sterilization-release (without transmitters) is sometimes suggested as a method to reduce too large game populations, as a complement to or instead of e.g. shooting. Such a system would be extremely wasted for the RD. Judas animals as described above have much better effect since one Judas animal can be used to find and either cull or capture many new animals, while an animal released without transmitter will only find, pair up with and indispose one partner during its lifetime.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Acceptability has been high in the Nordic countries, but the method may be seen as unethical, especially by the animal right movement but also by people in common.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	At low population densities Judas animals are very cost efficient, but much less so at high densities. However, the information they allow to be collated on dispersal, habitat selection and distribution hotspots may still be very useful for the management.
Level of confidence [2] See guidance section	High. Judas animals are used for eradication of many different invasive species across the globe. They are more effective in low densities and would be the first choice tool for a country/region that do not have established populations. To trans-locate judas animals in front of the dispersal zone (as

	proven by the example from non mainland Denmark) could be a very cost/labor effective way of tackling early invasions. Experience from the Nordic RD project and expert opinions from respective country confirms the level of confidence especially regarding the RD.

Rapid eradication - Measures to achieve rapid eradication after an early detection of a new occurrence (cf. Article 17). This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for each of the eradication measures identified.**	
Measure description Provide a description of the measure	**Professional hunters** To successfully eradicate a population of RD, professional hunters, employed for the task, are required to undertake the most difficult aspects of the work. No matter how dedicated, voluntary hunters will not achieve eradication. They can successfully manage a population and keep it at a reasonable level (see Voluntary hunter table under management), but not eradicate (Dahl and Åhlén *et al.*, unpublished results). Voluntary hunters can only hunt on their own hunting area, and not all hunting areas will be interested in participating. Voluntary hunters may also not get required permissions from the authorities as a project with employed professional hunters will, for example to use dogs all year around or to hunt on all areas if necessary. A voluntary hunter may not respond to a picture of a RD from a game camera at 3 AM the day before an important meeting. And finally, a voluntary hunter may lose interest when it takes two weeks to find a RD track. Employed professional hunters will do their job no matter how difficult or inconvenient it is. Professional hunters are also very important to efficiently manage cameras in early warning systems (see Game camera table under Early detection), and to manage a population (keep it at low levels and stop dispersal). However, regarding all measures of Early detection, Eradication and Management, It is highly recommended to complement the professional hunters with voluntary hunters. Just a few professional hunters cannot cover a whole country even though very efficient, and voluntary hunters, although many, will not spend all of their time on hunting RDs.
Effectiveness of measure e.g. has the measure previously worked, failed	In the Swedish management system in 2016, 26 out of 40 animals were captured or killed by the projects professional hunters. Many of these animals were a result of observations from the public, or partners to Judas animals. Few if any of these 26 RD would have been killed by voluntary hunters since they only hunt on their own hunting areas. Professional hunters add to the culling done by voluntary hunters (Dahl and Åhlén *et al.*, unpublished results).
Effort required	At least some professional hunters are necessary as long as the management is ongoing, as they

e.g. period of time over which measure need to be applied to achieve rapid eradication	provide expertise and effort that is not provided by voluntary hunters. How many depends on the goal with the management plan and how well developed the cooperation is with voluntary hunters.
Resources required [1] e.g. cost, staff, equipment etc.	In the Swedish system there are six full time professional hunters. They have several dedicated voluntary hunters each to help them, and in addition hundreds of voluntary hunters are helping when they can. In Sweden the goal is to eradicate the RD, or to get as close as possible to an eradication, and to ensure that it does not spread south in Sweden or west to Norway. It is probably not possible to fully eradicate the RD since they are common in Finland on the other side of the border, and occasionally RDs disperse to Sweden. However, it is important to keep the population at a very low level (Dahl and Åhlén *et al.*, unpublished results). In Finland there is only one full time professional hunter, who has hundreds of very dedicated and trained voluntary hunters to help him (Mikko Alhainen, pers. comm. 2017). The goal on the Finnish side of the border is to keep the population as low as possible with the means available so that few animals spread to Sweden and Norway. Denmark has six people employed for the RD management (not all full time) and 23 volunteer hunters connected to the project (Lars Trier and Karl-Åge Dalbæk Andersen, pers. comm. 2017). The goal is to keep the population low on Jylland and do not let them spread.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	The employed professional hunters get very good at practical management and can also work with similar issues, i.e. other new IAS (Dahl and Åhlén *et al.*, unpublished results).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Generally high since the culling involves an IAS, but the management may possibly be seen as unethical for some stakeholders such as animal rights organisations.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	See above.
Level of confidence [2] See guidance section	High. Professional hunters are a key tool for management and eradications of invasive species across the globe. Recreational hunters have limited time and are restricted by hunting laws from using the most effective culling methods. The combination professional hunters, specially trained dogs and MMS-cameras have proven to be very effective in the Nordic countries. Experience from

	the Nordic RD project and expert opinions from respective country confirms the level of confidence especially regarding the RD.

Rapid eradication - Measures to achieve rapid eradication after an early detection of a new occurrence (cf. Article 17). This section assumes that the species is not currently present in a Member State, or part of a Member State's territory. **This table is repeated for each of the eradication measures identified.**	
Measure description Provide a description of the measure	**Hunting dogs** Hunting dogs specially trained in hunting the RD are an invaluable tool in management of this species. It is possible to locate and confirm RDs with e.g. cameras, by their tracks, with DNA or by sight, but it is also necessary to capture them or get close enough to shoot them. Some types of dogs put the RD at bay (barking at the game and making it stand still) on the ground and others are released into the den to bay the animal down in the den so the hunter can dig it out. Both methods are effective in their own ways. Once a picture of a RD has been received from a game camera. A hunting dog will be taken to the site and released on the track, which will follow it until finding the RD or a den where it has burrowed. If the hunting dog finds the animal above the ground, the dog will bark at the RD and keep it still until the hunter arrives. If the RD has hidden in the den, another (smaller) dog is released to bay the RD so the hunter can dig it out. The hunter can then kill the RD or take it alive, as they are easy to handle. Without a dog you can shoot the RD either by a chance or on a bait, but neither method is very efficient. The only way to catch a live RD without a hunting dog is by trapping, but not all RDs go into a trap (Lars Trier, pers. comm. 2017) (see trapping section). In Norway they have one specially trained dog, trained with the customs dogs, but to react on RD instead of narcotics. When the dog finds a RD track, it sits down (Erik Lund, pers. comm. 2017).
Effectiveness of measure e.g. has the measure previously worked, failed	The trained hunting dogs are very efficient. Swedish and Finnish professional hunters have assessed that using dogs they kill/capture over 90 % of all RDs reported by MMS cameras. Without hunting dogs probably less than 10 % would be captured or killed, with traps or shot on a bait (Dahl and Åhlén *et al.*, Unpublished data).
Effort required e.g. period of time over which measure need to be	Dogs will have to be brought up and trained properly before becoming useful. It takes time (about two years) and effort to train them.

applied to achieve rapid eradication	
Resources required [1] e.g. cost, staff, equipment etc.	A dog may cost around 1,000 Euro plus costs for food, veterinary bills, insurance and a place to live. Usually the professional hunters care for the dog and may get compensated for the extra cost.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Dogs sometimes hunt other wildlife than RDs, and it may happen that other animals are killed by the dogs. In at least Sweden muzzles on the dogs are obligatory to avoid such accidents.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	In the Nordic countries acceptability is generally high. Other European countries have larger opposition against hunting dogs. However, if communicated the right way it is possible the acceptability can increase. People are in general very positive towards dogs in service to solve important tasks such as finding narcotics, leading blind people and catching criminals. IAS is one of the greatest threats towards native biodiversity and if the general public is made well aware that specially trained dogs are in service to solve this issue they could become more positive. These dogs are managing a societal problem; they are not hunting game to be killed for recreational purposes.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	None.
Level of confidence [2] See guidance section	High. The effectiveness of specially trained hunting dogs for this target species is well documented in the Nordic RD project. The combination of professional hunter, trained dog and MMS-cameras is producing nearly 100% culling results on confirmed RD pairs. Experience from the Nordic RD project and expert opinions from respective country confirms the level of confidence especially regarding the RD.

Management - Measures to achieve management (cf. Article 19). This section assumes that the species is already established in a Member State, or part of a Member State's territory. **This table is repeated for each of the management measures identified.**	
Measure description Provide a description of the measure	**Voluntary hunters**

	In almost all European countries hunting is a popular hobby, and sometimes also a business. A conservative assessment is that at least 7,000,000 hunters hunt game during the legal seasons (Dahl and Åhlén *et al.*, unpublished results). If informed, engaged with and included, hunters can be a very important part of the management of the RD as well as other invasive alien species by killing them on sight (shooting them during hunting of other species or on a bait station), or putting out traps to catch invading individuals (Dahl and Åhlén *et al.*, unpublished results). Hunters can either be totally voluntary, doing what they can with their own means, or encouraged with education, gifts or sometimes when appropriate salary by the hour and by covering travel expenses (Dahl and Åhlén *et al.*, unpublished results).
Effectiveness of measure e.g. has the measure previously worked, failed	For a management purpose, to keep the RD population on a reasonably low level, voluntary hunters are important and very cost efficient. However, it is unlikely they will be able to eradicate a RD population totally by themselves. In Sweden the voluntary hunters kill about 30% of all RDs that are culled each year (Svenska Jägareförbundet, 2017). In Denmark about 40 % of the total cull is made by voluntary hunters (Karl-Åge Dalbæk Andersen, pers. comm. 2017). In Finland the system is to a large extent built on cooperation with the voluntary hunters, and in the beginning of the management they can take a large proportion (approx. 50 %) of the total cull, which will decrease to 20-30% as the population density decreases and the role of Judas animals and professional methods increases (Mikko Alhainen, pers comm. 2017). In 2016 it was however noticed that the RD population was increasing slightly after many years of efficient culling (Finnish Wildlife Agency, 2016). It is an educated guess that the population in northern Finland has become so low that it is difficult to find new animals, and with that the voluntary hunters have lost interest (Finnish Wildlife Agency, 2016). Some hunters have stopped hunting, or relaxed their effort, since it is not as rewarding (Mikko Alhainen, pers. comm. 2017). Together with the fact that not all hunters and hunting areas are interested or have time to help with the management is unlikely they will be able to eradicate a RD population totally by themselves. They will however be able to keep the RD population at reasonable levels in important areas, especially in cooperation with the authorities and by using game cameras on RD baits (see Game Camera section) In Sweden voluntary hunters take a fair part (30 %) of the total cull, but less than on the Finnish side where the population is larger. In the northernmost county of Sweden, Norrbotten, where the majority of all Swedish RDs occur, there are about 20,000 moose hunters that go out in the woods each autumn. Since the moose dogs also put RDs at bay it is expected that they will shoot quite a few RDs. However, in recent years this cull has been very limited since there are very few RDs left

	(Svenska Jägareförbundet, 2017). The hunters are not expected to spend massive amounts of effort on hunting RDs specifically, when the population gets so low that it is almost impossible to find them. A pure bounty system, putting a value on the RD, and paying the hunters a sum of money for each animal they turn in is not used in the Nordic countries. A bounty system may be effective to manage established populations (Pasko and Goldberg, 2014), but has received a lot of criticism (Wittenberg and Cock, 2001). By putting a value on the managed species there is the risk that people will protect them and let them breed to earn money (Gherardi and Angiolini, 2009). In addition, it would be very easy to drive from Sweden to Finland to buy shot animals cheap and sell them in Sweden or Norway.
Effort required e.g. period of time over which measure need to be applied to have results	To encourage hunters to assist in the management, it is important that they are informed and educated so that they know what to do if they see a RD during hunting. In Finland and Sweden the projects also organise courses on building traps and how to hunt RD with hunting dogs (Finnish Wildlife Agency, 2016). Since the measure is cheap and local hunting will take place with or without RD management, the encouragement to cull RDs should be continuous.
Resources required [1] e.g. cost, staff, equipment etc.	Resources required include information and education costs and possibly material costs for traps. In Sweden and Finland hunters that are very involved and help the project a lot, or capture a lot of RDs, also get gifts when appropriate for further encouragement, such as a gift certificate or a pocket knife. The cost of involving the hunters is very limited compared with what the project gains in the form of killed animals (Finnish Wildlife Agency, 2016; Svenska Jägareförbundet, 2017). In Sweden there is also a system of semi-professional hunters that have received a more comprehensive education from the project managers to take on a larger responsibility such as field verification of RD records reported by the public (Svenska Jägareförbundet) (see also the citizen science observation system section). Hunters in the Nordic countries are usually very willing to help if they know that without doing so there may be negative consequences for their own hunting area.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	There is a possibility that hunters shoot one RD out of a pair but not the other one. The remaining RD will then after a while start to disperse to find a new partner. In the worst case scenario the hunter may then have contributed to an increased dispersal of the species, if the dispersing individual finds a new mate outside the previous distribution area. It is therefore very important that hunters report their killed animals to the professional hunters, so that the area can be properly investigated for potential partners of the individual that was removed. This can be done by releasing a Judas animal of the same sex as the shot one in the area (Dahl *et al.*, 2012). Information and education of hunters are important to avoid this and similar events. The positive side effect is

	awareness raising among hunters. As a result other IAS species can be effectively managed.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Should be very acceptable since the hunters are voluntarily providing a societal benefit while performing their legal hunting. Some people will however never accept animals being shot, even if it may be a threat to native species.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	Local hunters are already active in all European countries. With very limited resources, information can be spread to make hunters pay attention to the problem. The hunting culture and the organization of hunting differs between European countries, but at least in some countries it would be possible to implement a deeper cooperation between managing authorities and hunters, similar to the Nordic countries, and with that follows also an increase in costs, but which without doubt would lead to a very cost efficient system.
Level of confidence [2] See guidance section	High. hunters are the key tool for game management across the globe. If threats from IAS towards biodiversity is communicated the right way recreational hunters could be a very valuable resource in the management of IAS especially in established populations in need of control. Experience from the Nordic RD project and expert opinions from respective country confirms the level of confidence especially regarding the RD.

Management - Measures to achieve management (cf. Article 19). This section assumes that the species is already established in a Member State, or part of a Member State's territory. **This table is repeated for each of the management measures identified.**	
Measure description Provide a description of the measure	**Trapping** Traps of various kinds are often used in conservation. They can be used by professional hunters, and are commonly used by voluntary hunters in their private hunting for hunting various kind of game. Traps can be both lethal and live capture, but only live traps are used for RD in the Nordic countries. The trap is set where the animal is expected to be or pass by. A bait or a scent lure is used to get the animal to enter the trap. Live traps have to be checked twice per day in the Nordic countries which take a lot of time. Cameras or trap alarms can be used to become more cost-efficient (see camera traps section above). There are many different traps available for RD trapping.

	One of the most efficient ones is the KANU-trap, a Finnish cage trap (https://riista.fi/sv/jakt/direktiv-for-jagare/metsastystavat/fangst-med-falla-och-sax/).
Effectiveness of measure e.g. has the measure previously worked, failed	In countries with a strong trapping culture and where the hunters are willing to help with the management, such as in Finland, traps can be an efficient tool to keep the population at a reasonably low level. It is doubtful however if traps alone can eradicate populations of the RD (see voluntary hunters section). Traps can capture a lot of animals in high density populations, when food is scarce, or young and naive animals. Traps are usually less effective on adult experienced animals. This also applies to the RD. Pups are easy to capture outside a den. If food is scarce adult animals will also enter the trap, i.e. outside a den in mid-winter. Traps are quite easy to manage and one hunter can manage many traps. In the Finnish RD project 20-25 % of the culled animals are captured with traps, mainly by voluntary hunters. Many days are however required to capture one RD. In a low-density population, such as in Lapland, an average trap adequately baited and set up in a strategic point will capture less than one animal per year. In the key areas of invasion the best traps can catch 1-5 animals per year, especially if there is there is a reproduction close by. In low-density areas where the focus is to stop the invasion, the purpose of the traps is to capture the first arriving animals. For example on the Tornio river (border river Sweden/Finland) island a trap was set and well baited for 3 years before the first RD was caught, but without the trap the animal would have crossed the river into Sweden (Mikko Alhainen, pers comm. 2017). In Denmark the experience with bait-traps is that it is very hard to catch RDs in these. Only very seldom do adult RDs enter these traps the same day as they are seen on the MMS-camera surveilling the trap. Often it's necessary to very persistently and thoughtfully bait for weeks to trick the RD to take the bait and get caught. The game cameras show the RDs are very wary regarding the traps (Lars Trier, pers. comm. 2017). In high density populations many RDs can be captured with just one trap, in southern Finland there are examples of 18 captured animals in 60 days for one trap (Mikko Alhainen, pers comm. 2017). Traps are not very cost-efficient for a few employed professional hunter, many traps will take a lot of time without capturing very many animals. However, if many voluntary hunters are involved in the management, trapping can account for a large part of all captured animals, even if the hunters only have one or two traps each.
Effort required	To be as efficient as possible, trapping should be ongoing all year around. In late summer and early

e.g. period of time over which measure need to be applied to have results	autumn trapping is efficient at capturing pups that are starting to move around by themselves.
Resources required [1] e.g. cost, staff, equipment etc.	Some traps can be built by hunters themselves. National authorities (or projects) can then buy material and arrange building events, where hunters can be informed, build their own traps and be associated to the management. Buying large numbers of commercial traps, cameras and alarms can be quite expensive.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Trapping of non-target species does occur. However, as they are not lethal traps they can be let out again and therefore has limited to no negative effects. During the breeding season (if legal to trap at this time) it is important to check the trap often, so that pups are not deprived of food for longer periods of time. Sometimes also pet animals such as dogs are captured (Dahl and Åhlén *et al.*, unpublished results).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Usually accepted by most if it is a common hunting method to begin with. If trapping during breeding time is allowed, it may be seen as unethical even though the RD is an IAS.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	One RD trap costs approximately 200 Euro, and the material cost for building it yourself is 70-100 Euros. In Northern Finland approximately 1 trap per 1,000 ha is deployed by voluntary hunters in the key working area of South-Western Lapland when the efforts are focused around the key corridors such as main rivers and roads. This intensity has had an important role in the decrease of the RD population in South-Western corner of northern Finland 2011-2015 (Mikko Alhainen, pers comm. 2017).
Level of confidence [2] See guidance section	High. Traps are used for IAS work as well as normal game management across the globe and are especially important for long term work in established populations. Experience from the Nordic RD project and expert opinions from respective country confirms the level of confidence especially regarding the RD.

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Notes

1. Costs information. The cost information depends on the information available.

2. Level of confidence provides an overall assessment of the confidence that can be applied to the information provided for this method.

- **High**: Information comes from published material, or current practices based on expert experience applied in one of the EU countries or third country with similar environmental, economic and social conditions.
- **Medium**: Information comes from published data or expert opinion, but it is not commonly applied, or it is applied in regions that may be too different from Europe (e.g. tropical regions) to guarantee that the results will be transposable.
- **Low**: data are not published in reliable information sources and methods are not commonly practiced or are based soley on opinion; This is for example the case of a novel situation where there is little evidence on which to base an assessment.

3. Citations and bibliography. The APA formatting style for citing references in the text and in the bibliography is used.
e.g. Peer review papers will be written as follows:
In text citation: (Author & Author, Year)
In bibliography: Author, A. A., & Author, B. B. (Publication Year). Article title. *Periodical Title*, Volume(Issue), pp.-pp.

(see http://www.waikato.ac.nz/library/study/referencing/styles/apa)