Information on measures and related costs in relation to species considered for inclusion 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.

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Species (scientific name)	*Neovison vison* (Schreber, 1777)
Species (common name)	American mink
Author(s)	Sugoto Roy
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Reviewer	Peter Robertson, Newcastle University, Newcastle upon Tyne, United Kingdom

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.
Neovison vison is a small carnivorous mammal in the order Mustelidae. It was introduced to Europe through the fur-farming industry and since the first half of the 20th century it has spread through a combination of deliberate release or escape from the fur-farming establishments. Although commercial fur farming has decreased in some member states such as the Republic of Ireland, and been banned in others, like the UK, (Roy, Reid, & McDonald, 2009)the European Union remains the world's largest producer of farmed fur, accounting for 60% of global production (Hansen, 2017). Global mink fur

production has increased, a trend reflected in Denmark and Poland (Ministry of Environment and Food Denmark, 2017). In countries where biosecurity regimes are poor, for example in parts of Scandinavia (Pertoldi et al., 20130), escapes account for a large proportion of the wild population. In addition the feral population of the species continues to expand its range through natural population processes. The species has recently colonized large sections of Italy, including Venice since 2008, and continues to spread. It does not appear to be limited by either the cold or warm climates found within Europe.

Ecologically, the species has a range of impacts where it is introduced. These include predation on small mammals, reptiles, amphibians, and ground nesting birds. In addition, the species is a competitor of similar sized carnivores, in particular the European mink, *Mustela lutreola*. The species is a known vector and reservoir of a number of zoonoses, including several strains of toxoplasmosis. Economically, the species has impacts on fish farms and sport fishing, as well as on poultry and the sport hunting bird species.

As with all invasive species, prevention of introduction to new areas is a key component in managing invasion risk. This is particularly pertinent to offshore islands and archipelagos, where the species has a considerable impact on ground nesting bird species, in particular colonial seabirds. The most frequent pathways of introduction include deliberate release of animals from fur-farms by animal-rights organizations, or accidental escape from ill managed establishments. Although it is not easy for the species to spread accidentally, there are anecdotal reports of mink being transported by boats.

The species is relatively easy to detect in the wild in comparison with other small carnivores. This can be through either direct observation, or the finding of kills (birds and amphibians). The latter requires a degree of training, although sport fishing and bird watching organizations can facilitate the use of citizen science to report presence/absence of the species. In addition there are a number of bespoke methods to detect the species, used by professional or scientific organizations. These range from low tech systems such as the detection of faecal material (scats) or the placement of substrate to record footprints, through to more sophisticated techniques such as the use of camera trapping or more recently the use of environmental DNA collected from rivers and lakes/ponds.

There are a range of control techniques for managing populations either for eradication, complete removal or long-term control. These range from the use of live-capture traps, traps placed on floating rafts (often combined with footprint detection substrate), the use of dogs to detect presence where animals are to then be removed by trapping. Advances in control methods include the use of self-reporting traps, often monitored through the internet, or lethal traps that re-set themselves. Carnivore specific toxins focused on the Mustelidae have been developed, but are not currently licensed for use in Europe.

There have been a range of successful control/eradication operations. These include one in the outer Hebrides where archipelago-wide eradication is near completion after an initial pilot phase in the Uists, where a number of techniques were trialled. There have also been regional removal operations through the collaborative efforts of landowners, stakeholders and volunteers in northern Scotland, and removal from an island in Estonia to safeguard European mink populations. The complete removal of the species is labour and cost intensive with costs estimated between \$1400- \$6000/km^2 (Robertson et al., 2016) and requires extensive monitoring during and after operations, together with bio-security plans to prevent reinvasion. It is easiest to manage the species on islands with well-defined borders, often beyond the swimming distance of the species from areas where they occur. This is due to the high dispersal ability of the species over land and water, making management on continental systems more difficult.

Prevention – measures for preventing the species being introduced, intentionally and unintentionally. **This table is repeated for each of the prevention measures identified.**	
Measure description Provide a description of the measure	**Restrict importing, keeping, breeding, releasing American mink**. Article 9 of Regulation 1143/2014 however provides for authorisations for reasons of compelling public interest, including those of social or economic nature. The authorisations would allow Member States to issue permits to establishments according to Article 8, provided that they fulfil the conditions described in that article, including keeping and handling the species in contained holding. This measure would affect private collections of animals, and industrial establishments farming mink fur. In the past furbearers, such as raccoon dogs, were also deliberately released into the wild as a source of wild fur as well (Kauhala, 1996). Apart from some licensed zoological collections in Europe (e.g. http://english.ranuazoo.com), there are few records of private collections with this species. All captive collections mentioned here therefore refer to fur farms. Globally mink production has been on the increase since ca. 2005, for example between 2010 and 2015, the production Denmark increased from 14 million pelts to almost 18 million (Ministry of Environment and Food Denmark, 2017). Europe currently produces 60% of the world mink fur, which employs approximately 100,000 people in the EU. Restricting the keeping of this species would impact a number of member states and would require detailed analysis before being undertaken (Hansen, 2017). In some countries, fur farming is banned (e.g. the UK), while in others it is decreasing e.g. in Ireland (Roy, Reid, & McDonald, 2009). Escapees from mink farms do however contribute to the wild population as seen in Denmark (Pertoldi et al., 2013) and in Ireland (two still persist currently) has been a major source of animals for the wild population and sightings geographically coincide with farm locations (Roy, Reid, & McDonald, 2009).

Effectiveness of measure e.g. has the measure previously worked, failed	Countries that have restricted fur farms have anecdotally fewer mink in wild populations and greater likelihood of success in managing them (Roy, Reid, & McDonald, 2009).
Effort required e.g. period of time over which measure need to be applied to have results	This approach requires a combination of policy, legislation and law enforcement, and would need considerable resources to put into operation. Strong engagement with the fur industry is required. It could be enacted relatively quickly if the species is listed by the European Commission.
Resources required [1] e.g. cost, staff, equipment etc.	This approach would involve policy and legislation experts, and development of mechanisms to ensure effective implementation that do not result in further escapes.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Permits for responsible farms could improve the image of fur farms.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Fur farmers would fear uncertainty and administrative burden. However, a permit following an authorisation would provide them certainty.
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	There will also be costs involved in convening and engaging with industry groups and the private sector
Level of confidence [2] See guidance section	**Medium** Although not much published material is available, some Europe wide studies are available (Bonesi & Palazon, 2007).

Prevention – measures for preventing the species being introduced, intentionally and unintentionally. **This table is repeated for each of the prevention measures**

identified.	
Measure description Provide a description of the measure	**Improved biosecurity on fur farms.** In case fur farms are authorised, then improved biosecurity to remove the escape risk needs to be proved. Research shows regular escapes creating population hotspots in the wild both in Ireland (Roy, Reid, & McDonald, 2009), and Denmark (Pertoldi et al., 2013). Measures include; restricted access to prevent vandalism and deliberate release, the regular checking and monitoring of fence integrity to ensure no escapes, double fencing, electric fencing and bespoke alarm systems that alert managers to damaged fencing, and instalment of CCTV and other detection measures, in particular around perimeters to monitor any animal movements. Contingency plans including traps and equipment need to be in place to ensure rapid response to any escape events. Although there are codes of practise available for handling animals in fur arms as outlined by the European Union (Standing Committee of the European Convention for the Protection of Animals Kept for Farming Purposes (T-Ap) Recommendation Concerning Fur Animals; adopted by the Standing Committee on 22 June 1999), these do not include recommendations on biosecurity, and focus instead on welfare.
Effectiveness of measure e.g. has the measure previously worked, failed	In Danish fur farms, where biosecurity is high, a large proportion of the feral population is still made up of farm animals (87%), as seen by stable isotope analysis, so the technique has so far proven to be not that effective (Hammershoj et al., 2005)). Fencing rules however keep improving (see document) and recent numbers of hunting bag in Denmark suggests that the feral population is decreasing since the introduction of more stringent fencing rules (ref. note on hunting numbers and feral population), although hunting might also decrease due to a decreasing interest in hunting the species.
Effort required e.g. period of time over which measure need to be applied to have results	Biosecurity standards would need to be designed and met. Although costs for infrastructure, fencing, electric fencing, CCTV, alert systems, and contingency response equipment are likely to be high, there is little information available on this.
Resources required [1] e.g. cost, staff, equipment etc.	Running an authorisation and permitting system, developing standards, inspections and enforcement.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Some farms may undertake hidden practises and run illegal and poorly maintained farms.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The farming industry may try to limit additional costs, although closure of farms due to failure to meet these costs may be the only other alternative.
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	
Level of confidence [2] See guidance section	**High** There is good evidence from Denmark and Ireland as outlined above. Economic analyses on the impacts of further regulating the industry is also available, as outlined above.

Prevention – measures for preventing the species being introduced, intentionally and unintentionally. **This table is repeated for each of the prevention measures identified.**	
Measure description Provide a description of the measure	**Improved biosecurity measures for marine transport** If the species is not currently present on an island it could colonise through accidental transportation across marine environments, especially to vulnerable sites in archipelagos and offshore islands. A key measure to prevent further spread is improved biosecurity measures supported by improved public awareness. Preventing accidental spread through marine transport, such as cargo or other boats could be facilitated through an education campaign to raise awareness amongst those responsible for boats and harbours to report sightings, encouraging boat owners to check boats. This could be supplemented by additional official checks by trained staff at harbours.
Effectiveness of measure e.g. has the measure previously worked, failed	These methods are not currently used widely, and robust associated protocols do not exist. An informal small-scale approach was used during the pilot phase of the Hebrides mink project to prevent animals from being moved from outside of the control area back into the area where the species was being eradicated (Roy, Chauvenet, & Robertson, 2015; Roy, 2011). One of the techniques was to simply regularly engage with fish farms, ferry companies and harbour masters to spread awareness. This technique led to the discovery of an unknown population in the far south of the island chain early on in the project. Additional training was also provided through slide show give at venues.
Effort required e.g. period of time over which measure need to be applied to have results	The species identification material is already available on the internet (e.g. http://www.vwt.org.uk/wp-content/uploads/2015/04/MustelidLeaflet.pdf). Training through workshops could be developed for authorities dealing with ports and harbours, and potentially coastal and maritime fish farms. This could focus on the pathways of introduction, risk management, identification and the appropriate response should animals be identified (see section on rapid eradication).
Resources required [1] e.g. cost, staff, equipment etc.	There are several steps to this process as outlined below, together with research/resource needs and estimated costs (speculative): • The identification of vulnerable areas and hotspots where ports and harbours could play a role in the spread of the species where it is not yet present, of high biodiversity value; • Design and roll out of training programme for identification
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	None known; although the above does have cost implications.

Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Awareness raising campaigns are likely to be well received by 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 - the socio-economic aspects	The species is already widespread, and the process described above serves to prevent further spreading to areas which are ecologically and economically vulnerable. The cost for member states of preventative measures and awareness raising is unlikely to be large, and is particularly outweighed by the costs of having to completely remove the species which even over smaller landscapes is hugely expensive (estimated at $1400-6000/km^2 (Robertson et al., 2016)). The cost-effectiveness of rolling out a simple standardized training programme is favourable.
Level of confidence [2] See guidance section	**Medium** The information to support this assessment is based on practical experience of its application at a local scale.

Early detection - Measures to 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**; *the recording of sightings by the lay public*. When data reported by the public are collated and coordinated, it can deliver a useful tool in detection and mapping of priority areas where early intervention can then have immediate impacts (Maistrello et al., 2016). This is also true for small carnivores which, although difficult to see in the wild, are seen nevertheless by the general public, and by special-interest groups such as farmers, anglers and hunters. Data from these groups have been shown to be highly useful in mapping and retrospectively dating introduction periods for invasive small carnivores such as mink and pine martens as demonstrated in the West Coast of Scotland (Faulkner et al., 2016; Solow et al., 2013). Increasingly, statistical techniques are continuously being improved to make better use of such data in real time. Therefore simply collecting and collating sighting data is a useful basic start. In addition, improved awareness campaigns at vulnerable points of entry such as ports can improve data collection from the public, together with a more targeted campaign aimed at specific user groups.

Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	Sighting data has been used for small carnivores, and has been shown to be a useful and robust method in collaboration with other techniques listed below (Solow et al., 2013; Faulkner et al., 2016).
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	Sighting-based information as described above can be collected with little or no cost. There are already some EU level schemes in place for using citizen science to develop and monitor indicators (Streamlining European 2010 Biodiversity Indicators, SEBI). However relying on it for long-term surveillance requires continuous awareness raising efforts and the support of both the local community, stakeholder groups and the public at large, together with sophisticated statistical analysis by an institution (Roy et al., 2012).
Resources required [1] e.g. cost, staff, equipment etc.	For basic sighting-based data, these can be collected at no cost especially if there is an ongoing management or eradication project running alongside. Any cost incurred would relate to statistical and spatial analyses at a research institution, and awareness raising. It is not possible to estimate the cost of a web-based or smart phone, recording platform, as these vary widely.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	Positive side effects included greater public and stakeholder awareness of invasive species and the wider environment in general. Monitoring for the species will also assist the surveillance of other invasive alien species such as raccoon dogs and raccoons and could form part of a coordinated effort across species.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Stakeholders should be amenable to the monitoring of environments for the species as they would benefit from early detection and intervention. At the detection stage, there are no animal welfare implications.
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	Costs mainly relate to recording platforms, (e.g. web based data collection, smart phone applications) and awareness raising so public maintain effort.
Level of confidence [2] See guidance section	**High** There are a large number of mammal monitoring projects that make use of public sighting data, both in the UK; (https://www.bto.org/volunteer-surveys/bbs/latest-results/mammal-monitoring) and in Europe (https://www.eea.europa.eu/data-and-maps/daviz/biodiversity-observation-schemes-using-citizen-science).

Early detection - Measures to 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	**Professional monitoring**. Professional monitoring is more targeted and costly than citizen science, but delivers more reliable results. Professional monitoring techniques vary, and can include less expensive methods such as the searching for scats and signs such as prey remains, and footprints. Where stakeholders regularly employ dogs (such as hunting estates), these could be trained to detect mink. Dogs have been used successfully in the detection of low density populations of a large number of invasive small carnivores such as mongooses in Japan, and mink in UK (Fukuhara et al., 2010; Roy et al., 2015). These monitoring methods can be made even more effective by augmenting through recording media such as footprint plates, especially placed on rafts (Reynolds et al 2004). More expensive techniques include the routine setting of camera traps, with sites made more attractive by the use of scent lures (Roy, Macleod, & Moore, 2006). At the high cost end of the spectrum techniques include the routine collection and sampling of water from riparian environments to search for environmental DNA (Thomsen et al., 2012). However, these techniques and technologies are becoming increasingly available and affordable.
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	Searching for scats or the setting of rafts provide reliable sighting information within certain confidence limits (Reynolds, Short, & Leigh, 2004). At low densities, the reliability of all these low technology techniques are decreased (Harrington et al, 2010; Harrington, Harrington, & Macdonald, 2008). Camera trapping technology is improving and increasingly affordable. For small carnivores it has shown mixed results, especially at low population densities but these are improving (Rockhill, et al 2006). Similarly, scent lures may make certain sites more attractive, improving likelihood of photographing animals. Dogs are also effective in combination with other techniques, and as part of a broader programme of work. As yet environmental DNA has not been used for small carnivores, but is likely to be in future. *As a caveat, it should be noted that as a result of control pressure, or through competition with*

	increasing populations of native carnivores such as otters, mink may change their behaviour and become more terrestrial. As a result, surveillance confined to riparian habitats may underestimate mink presence (Bonesi, Chanin, & Macdonald, 2004; Krawczyk, Bogdziewicz, & Czyż, 2013).
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	In order to put into place bespoke detection protocols, such as searching for scats, requires the coordination of key stakeholders such as landowners/gamekeepers etc. and developing an effective data collection platform and protocol. Such a system is already in place for the detection of rare species such as pine martens in Britain (Solow et al., 2013). Raft and camera based detection systems require training on top of this. For advanced techniques such as the use of environmental DNA, further research is required to make it applicable to this scenario, and a regular screening protocol needs to be designed. In future, "pocket diagnostics" technology may be available for rapid detection from water samples, as is currently done for a range of different field-based sample screening (Kox et al., 2007). The use of dogs, requires the purchase, care, and training of suitable strains/breeds. Where organizations regularly use them, this should not require extra effort other than training.
Resources required [1] e.g. cost, staff, equipment etc.	The regular searching for scats requires stakeholder group staff time such as hunting organizations. It could be made more efficient by the use of rafts which can be used to collect footprints (Reynolds et al., 2004), although the rafts themselves would require construction and maintenance (crudely estimated by the author at €100-200 a year). Camera trapping is becoming increasingly affordable (€200/camera, with batteries that last >six months). Placing these along riparian/coastal habitats provides a focus (although see note above regarding mink becoming terrestrial). Checking these on a monthly basis may be sufficient to detect species incursions but there remains uncertainty regarding the use of this method for mustelids. Vulnerable areas such as high biodiversity sites should be checked at appropriate times of year when they are vulnerable (e.g. bird colonies during the nesting period). As yet, environmental DNA is not sufficiently developed as a monitoring tool for mink. However, with increasing research it could be, and should be both rapid and relatively inexpensive.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	Surveillance for this species would bring wider benefits for environmental monitoring and the detection of other invasive species.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Stakeholders should be amenable to the monitoring of environments for the species as they would benefit from early detection and intervention. At the detection stage, there are no animal welfare implications.

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	Early detection would lead to early intervention. The deployment of camera traps/rafts/dogs by targeted stakeholders such as hunting estates and fisheries would in the longer run save a lot of money than would be needed for wide scale landscape level species management. An established population would impact upon important economic fish and game species and inaction would impact these industries together with biodiversity impacts.
Level of confidence [2] See guidance section	**High** There are a number of standardized protocols in place for the detection of small carnivore species by professional ecologists.

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	**Combined trapping techniques for rapid eradication over small geographic scales.** Once detected, rapid eradication is recommended. However, this does not occur in isolation, and detection and surveillance needs to continue to support any eradication schemes. The following is laid out in a series of incremental steps in removing animals as part of a campaign for rapid eradication: The techniques include the setting of live-capture box traps. This is effective if placed at an appropriate spacing of approximately one trap every 400m (Roy et al., 2015), which can be made more effective still by the use of scent as bait rather than food-based bait (Roy et al., 2006). In appropriate habitats, trapping can be combined with detection technology such as those provided by the raft systems with inbuilt footprints recording media. In these circumstances, traps need only be operated once footprints are detected (Reynolds et al., 2004), reducing staff costs. Traps can be supplemented with lethal, self-resetting traps such as those developed by GoodNature New Zealand (Carter et al., 2016). These can repeatedly kill target species up to 24 times and need only periodic checking. However, they have yet to be used on a significant scale to allow their effectiveness to be determined, and there is a high rate of mis-strikes and the potential for impacts

	on non-target species.
Effectiveness of measure e.g. has the measure previously worked, failed	Rapid eradication is feasible using a combination of the techniques outlined above, as long as populations are contained. There are very few examples of rapid intervention where populations have been removed after recent incursion. The only examples include the rapid rounding up and trapping of animals after deliberate release from fur farms by animal rights organizations (https://www.theguardian.com/uk/1998/aug/17/animalwelfare.world).
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	If intervention is instantaneous, short-term intensive effort is sufficient based on the article above. However, if not, then a more detailed and planned course of action is needed. It is recommended that equipment and emergency plans are in place in vulnerable locations (ports and harbours) in order to prevent spread, establishment, and thereby necessitate longer-term, more costly action.
Resources required [1] e.g. cost, staff, equipment etc.	The provision of traps, rafts, camera traps, euthanasia equipment, bait and scent lures can be stored in a centralized repository that is easily accessible by sites where incursion has a high probability, and authorities or other bespoke bodies can be given responsibility. A small degree of training for trapping and euthanasia is needed through information dissemination at regional workshops. The chosen methods should be kept under review as new technologies such as self-resetting traps become more widely used.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	There are no significant public health, environmental or non-target side effects of setting up a rapid response capability as described above.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Lethal trapping may be unacceptable to some stakeholders, and all traps will always require careful monitoring when set. Live-trapping is likely to require euthanasia of captured animals (using air pistol/rifle or injection of drugs such as Euthasol). This would require training to ensure humane standards are met. Even then, some stakeholders would find it unacceptable.
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	Inaction in dealing with a small population would lead to establishment and spread. The species is highly mobile over both land and water. Once established, widespread populations are difficult and costly to eradicate, and managing them is less cost-effective. The species has a number of impacts ecologically and economically in areas of high biodiversity or rural agriculture were hunting of game birds, sports fishing or the keeping of poultry is common.
Level of confidence [2] See guidance section	**Medium** There is not much information as rapid removal examples are few for the species.

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	**Combined trapping techniques for eradication over long-term and at a landscape scale.** Longer–term eradication or complete removal measures need to be undertaken to remove well-established, widespread populations at landscape scales, where rapid removal has previously failed or were not taken. They should only be undertaken where populations have no chance of recolonizing sites through natural processes or resources are available to manage the risks of reinvasion, and if sufficient resources are available for the entire, envisaged project lifespan (Bomford & O'Brien, 1995). The techniques included are similar to those of rapid eradication, but are applied over greater scales. These include the setting of live-capture box traps. This is effective if placed at an appropriate spacing of approximately one trap every 400m (Roy et al., 2015), which can be made more effective still by the use of scent as bait rather than food-based bait (Roy et al., 2006). In appropriate habitats, trapping can be combined with detection technology such as those provided by the raft systems with inbuilt footprints recording media. In these circumstances, traps need only be operated once footprints are detected (Reynolds et al., 2004), reducing staff costs. Traps can be supplemented with lethal, self-resetting traps such as those developed by GoodNature New Zealand (Carter et al., 2016). These can repeatedly kill target species up to 24 times and need only periodic checking. However, they have yet to be used on a significant scale to allow their effectiveness to be determined, and there is a high rate of mis-strikes and the potential for impacts on on-targets. Using dogs to find breeding animals at den sites and also to detect for the mere presence /absence at low densities is also a useful additional technique.
Effectiveness of measure e.g. has the measure previously worked, failed	Long-term eradications/management to near zero densities have been successfully undertaken in the Hebrides (Roy et al., 2015), which used an adaptive approach targetting a combination of both logistical and technical adaptations that exploited behvaioural patterns in the species. They have also been used across large areas of Northern Scotland (Bryce et al., 2011).
Effort required e.g. period of time over which measure need to be	This approach requires a high degree of planning, landholder and stakeholder engagement and fund-securing. It needs a greater degree of scientific input in project design and management. The

applied to achieve rapid eradication	first phase of the Hebridean project covering an area of 850km^2 cost £1.6 million and lasted 5 years. The entire Hebridean Archipelago eradication, including the first phase and totalling 3,460km^2, has taken 16 years, and is still not complete in 2017. Over 4 years, the Northern Scotland project effectively removed mink completely from 4 river catchments across just over 10,000km^2 (Bryce et al., 2011).
Resources required [1] e.g. cost, staff, equipment etc.	The first phase of the Hebridean project cost £1.6 million using 8 core staff, the entire Archipelago –wide programme has used up to 9,000 traps and at any one time has employed up to 12 staff, though this has varied seasonally (Lambin 2014). Costs cannot be estimated for this as this work is ongoing. The Northern Scotland project (Bryce et al. 2011) has used more than 800 volunteers to keep down costs. Using rafts was appropriate in this case, as river systems are more geographically defined than in the Hebrides, >300 were used. A review by Robertson et al. (2016) has shown that although costs of large scale eradications is high, costs per unit area decrease as larger areas are managed.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	There are no significant public health, environmental or non-target side effects (excluding lethal, self-resetting traps) of setting up a landscape scale eradication programme as described above.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Lethal trapping may be unacceptable to some stakeholders, and all traps will always require careful monitoring when set. Live-trapping is likely to require euthanasia of captured animals. In addition access to the land of a large number of stakeholder may be required and this may be difficult to get.
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	Due to the cost of these schemes, large consortia, procurement of equipment and training of staff, and a high degree of coordination is needed. These add to the costs.
Level of confidence [2] See guidance section	**High** There is a large body of information available on the successes and failures of long term eradication campaigns.

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	**Long-term integrated management strategies.** Where eradication is not an option, there are a number of longer term management strategies that may be of benefit. For longer term management there is usually a shift in focus from targeting management techniques to simply predator control, to targeting seasons and locations to protect vulnerable species of conservation concern (Roy & Robertson, 2017). The specific management measures that can be used are detailed below in the proceeding Management tables, and include exclusion via fencing, refuge creation for vulnerable species, trapping, and the use of toxins.
Effectiveness of measure e.g. has the measure previously worked, failed	As a strategy focussing on vulnerable species and sites is effective. However it is indefinite as there are always source populations from which animals can recolonize managed areas.
Effort required e.g. period of time over which measure need to be applied to have results	Once populations have been reduced initially to safeguard species of conservation concern, a regular sustained lower level management effort is needed to manage the species indefinitely. Targeting breeding females in particular is a strategy that provides a good return on investment as it removes a large number of resident animals at once.
Resources required [1] e.g. cost, staff, equipment etc.	This approach is resource intensive as it requires all the equipment of a normal trapping campaign (albeit over smaller/targeted areas of conservation value), but continues indefinitely.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Maintaining long-term engagement with landowners over time would develop good local partnerships.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Some stakeholders/land owners may not be amenable to maintain long term management activities indefinitely.
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	As an indefinite activity, costs are difficult to estimate.

Level of confidence [2] See guidance section	**High**, as a strategy there are a number of scenarios where this is used, so information is available

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	**Exclusion through fencing.** One technique is physical exclusion of animals from vulnerable areas, primarily through fencing. In combination with the trapping techniques with rafts and traps, described in previous sections this may have some benefit.
Effectiveness of measure e.g. has the measure previously worked, failed	Fencing for mink is not effective due to the ability of the species to cross areas of both land and water, combined with its ability to dig and its small size facilitating its ability to squeeze through small spaces, therefore fences need to be of a high tech small mesh size which is expensive (Wade, 1982).
Effort required e.g. period of time over which measure need to be applied to have results	For exclusion to be effective, it requires a huge expense with fences crossing terrestrial and riparian environments. This is not effective in coastal environments where animals can swim out to sea and then back again. Traps also need to be buried into the ground deeply and need to be of a small mesh size. This greatly increases the cost and only works for small areas.
Resources required [1] e.g. cost, staff, equipment etc.	This technique is costly as it requires bespoke predator – proof fencing which is costly to purchase, install and maintain.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	If used, fencing would reduce or impede the movement of a number of native species across barriers, and this would need close monitoring to ensure gene flow of vulnerable species.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Fencing may be unacceptable to some stakeholders such as hikers, as it may impose access restrictions.
Additional cost information [1] When not already included above, or in the species Risk	Fencing would still need to be combined with trapping as described in previous sections to ensure areas are mink free. Fences need indefinite maintenance and monitoring to ensure their integrity.

Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	These are long term costs.
Level of confidence [2] See guidance section	**Medium**; there are a number of studies looking at fencing effectiveness (Barun et al., 2011)

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	**Refuge creation for vulnerable species.** Another technique to protect species of conservation or economic concern from mink is the creation of refuge habitats, which are specific habitat types to protect aquatic and terrestrial species of conservation concern by providing hiding places where they are less likely to be preyed on (Carter & Bright, 2003). It could be combined with trapping as described in previous sections, and even fencing as described earlier.
Effectiveness of measure e.g. has the measure previously worked, failed	Refuge creation has been effective at protecting some water vole and crayfish species from mink predation (Carter & Bright, 2003). It is effective for protecting high-value species in small areas, but in combination with other techniques could be rolled out over catchment scales as an effective additional conservation measure opportunistically. Refuges include areas and islands of dense floating vegetation, steep sided floating islands where gull and tern species can nest or dense riverbed vegetation where crayfish can hide.
Effort required e.g. period of time over which measure need to be applied to have results	Refuge creation is a cheap addition to any other management or conservation technique where a number of target species of conservation concern can be assisted by creating areas where it is difficult for mink to prey on them. It is not difficult or expensive to create specific areas of dense vegetation, or floating polystyrene islands that are then vegetated for nesting aquatic bird species.
Resources required [1] e.g. cost, staff, equipment etc.	Where there are species of conservation concern that would benefit from this approach, the resources needed are limited and not expensive. Floating rafts and vegetation to create islands systems where access and predation by mink is difficult.

Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Refuge creation should have no or limited side effects on all the species. Indeed, a number of species could benefit from them, e.g. gulls could use tern nesting sites.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Refuge should face little or no opposition from 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 - the socio-economic aspects	Refuge creation alone will not be effective but it does need to be supplemented by other techniques which does have associated costs.
Level of confidence [2] See guidance section	**Medium** There are a number of scientific studies showing the added value of refuge creation. Few show their effectiveness however in combination with other management techniques

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	**Adapting trapping strategies to long-term management.** Live trapping as described in earlier sections can be adapted to make the technique more suitable for long-term management by reducing costs and being made more efficient over longer periods of time. The system of combining foot print detection with subsequent trapping using rafts has already been described (Reynolds et al., 2004). Advancement of this strategy includes the use of self-reporting systems which notify operators of their status. This reduces manpower costs as staff only need to visit traps as and when they close. (e.g. www.minkpolice.com). Where lethal traps are permissible, their use can be cost effective but care is needed to ensure animals are killed humanely and there is little or no risk to non-target species. Such traps include

	jaw traps, snares and derivatives and would need to be approved by the Agreement of International Humane Trapping Standards (EC Council Decision 98/142/EC)[1] (see also IUCN, 2005) and relevant national legislation. There are now models of lethal trap available that self-reset, again reducing manpower costs of checking and setting traps daily. These are under development for the species by a New Zealand company Good Nature, which has developed a baited trap that is powered by pressurized carbon dioxide to deliver a lethal strike to the head. The traps then resets itself in preparation for the next target (Carter et al., 2016). However, it still requires extensive testing.
Effectiveness of measure e.g. has the measure previously worked, failed	Lethal trapping can be effective where traps do not need to be checked every day, for example in areas where there are no non-target species (such as remote oceanic islets, in the case for mink), and lethality is highly likely. For humane reasons, lethal traps, usually still need to be checked daily once set to prevent inhumane treatment of animals not being killed instantly by the device. This negates the time-saving of simply setting traps and then checking them periodically.
Effort required e.g. period of time over which measure need to be applied to have results	This is an indefinite measure, but reducing costs will make this more affordable. An initial intensive reduction of the population followed by longer term management approaches may have the best impacts on population reduction (Roy & Robertson, 2017).
Resources required [1] e.g. cost, staff, equipment etc.	All of the different techniques require a large degree of staff, fuel, equipment and transportation cost. Live-capture traps cost approximately €6-€15 each and are easily baited. Checking traps daily itself is labour-intensive. It requires some training (one day), with further training in humane dispatch and hygiene (one day). An operative can check on foot up to 50 traps daily, depending on the terrain (spaced 200 – 400 m apart). This can be increased by using road networks effectively (Roy et al., 2015). An operative can check far more if the traps are self-reporting, and send a message by text when closed. This self – reporting system costs approximately €100 to setup for small clusters of up to 25-40 traps. The addition of rafts at a small cost (up to €60), adds efficiency. The raft system is effective where waterways are constrained to specific rivers and water channels, rather than convoluted coastal systems.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Live-capture box traps, and rafts will catch other non-target species, however the use of baffles could reduce non-target entry (Short & Reynolds, 2001). As they do not kill, non-targets could be released unharmed if checked frequently enough. Lethal trapping, especially with self-resetting traps provides a risk of non-targets being killed, although again species specific design would reduce this. The reduced incursion by trapping

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31998D0142

	operatives has the benefit of reducing disturbance to ecosystems.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Animal-rights organizations and other stakeholders may find eventual euthanasia of mink when using live-capture box traps unacceptable. There is scope to rehouse animals but in the long run this is costly and not recommended. Humane euthanasia techniques are essential. For lethal trapping, especially with self-resetting traps, it is essential that the traps act quickly and effectively. The less expensive game-keeper style traps are not as instantaneous as the more expensive self-resetting traps, and have more room for error. Regular carcass removal is recommended to prevent the build-up of biological waste material that could pose disease threats as the species carries a number of zoonoses (Bartley et al., 2013; Burrells et al., 2013).
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	Live-capture trapping on its own is never recommended as a section of the population is often trap shy and remain uncaptured. Alternative population monitoring techniques such as camera trapping is recommended. At the tail end of a trapping campaign, there is a long period of operation without capture which is often expensive in terms of staff time, and the use of self-reporting traps is recommended here. There are training costs and indefinite staff and trap maintenance costs. Lethal trapping, especially with self-resetting traps are expensive, and trap maintenance and replacement of parts is also costly and need to be built-in to management plans.
Level of confidence [2] See guidance section	**Medium**. This is a body of work that is growing.

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	**Toxins.** A number of toxins are available for mammalian targets. Recently, carnivore specific toxins have been in development. One such compound is Para-aminopropiophenone (Papp) and has been found to be highly effective for mustelids when formulated with meat based baits placed strategically in the environment at baiting stations (Eason et al., 2010).
Effectiveness of measure e.g. has the measure previously worked, failed	Poisoning campaigns are not widely used for small carnivores, as the non-target risk is high, and it is not certain whether all sections of the population are sufficiently exposed to the control effort,

	leaving population nuclei from which species could recover. However, the development of carnivore specific toxins (Mallick, et al., 2016) has reduced the element of non-target risk, in particular where the only other non-targets are non-mammalian. There are no toxins approved for use within the EU for this species. EU/national/local legislation on the use of biocides needs to be respected.
Effort required e.g. period of time over which measure need to be applied to have results	Poisoning campaigns require bespoke delivery means and training with a well-trained task force and clearly defined aims and objectives. Independent monitoring is required to track population declines and an intensive risk assessment is required to assess risk posed to non-target species before operations begin. The testing and licensing of carnivore specific toxins is imminent but not yet available.
Resources required [1] e.g. cost, staff, equipment etc.	Toxin delivery requires specific bait delivery systems and formulations such as fish carcasses accessible to mink and nothing else, or bait delivery hoppers (Gigliotti, Darby & Lapidge, 2014).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Toxins carry potential risks to non-target species, humans and livestock through both direct and secondary. These may be reduced through species specific action, formulation and bait delivery.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	There is likely to be significant concern from stakeholders to the use of toxins.
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	Toxins storage, or eventual disposal is costly. In addition some toxins require bespoke protective equipment and clothing and handling which adds to costs.
Confidence	**High,** Toxin use requires rigorous lab and field testing to ensure effectiveness. Those applied for rodent management for example are based on decades of science and best practise. If developed, any application to mink management should be similarly backed by science, risk assessment and compliance with the appropriate legislation.

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	**Immunocontraception.** Immunocontraception uses a vaccine to trigger a response in an animal's immune system to prevent it from reproducing, either by preventing implantation of embryos in utero or through prevention of fertilization of eggs. It is often used to treat wild caught animals that are then released, unable to breed, thus reducing the population size over time (Kirkpatrick, Lyda & Frank 2011). The species listed by Kirkpatrick *et al.* (2011) are large species where the strategy has been to keep wild populations to within acceptable thresholds. Delivery mostly relies on capture, treatment and then release. For species like mink, it would still entail and expensive trapping campaign, followed by treatment and then release. Also, all animals within a population would need to be put at risk, or fragmented breeding populations would still persist form which populations could quickly recover. The only scenario where this could be a good technique is where immunocontraceptives can be delivered through oral bait delivery.
Effectiveness of measure e.g. has the measure previously worked, failed	This method has not yet been applied to mink.
Effort required e.g. period of time over which measure need to be applied to have results	This is not a recommended technique until an immunocontraceptive vaccine for oral delivery has been developed for wide scale use on mink. The measure would need to be part of a permanent management plan.
Resources required [1] e.g. cost, staff, equipment etc.	As yet, this should not be undertaken. In general, the resources required would include traps (if used) and associated resources including trained staff and transport etc., and the vaccine and oral delivery system (bait, if used).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Once developed for wide scale oral bait delivery, baits would need to be delivered and formulated in ways that reduce impacts to non-target species (Gigliotti, Darby & Lapidge, 2014)
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	This may be perceived as humane by the general public. However avoiding non-targets will still be needed.
Additional cost information [1] When not already included above, or in the species Risk	This cannot be estimated as yet.

Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspect	
Confidence	**Low,** A lot more development and research is needed.

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	**Hunting.** Hunting using firearms and additionally dogs to locate catch or kill free living mink.
Effectiveness of measure e.g. has the measure previously worked, failed	Due to the low profile of the species, and its fossorial behaviour, general use of firearms would be difficult as a management measure for the species. The species has been hunted in the past with hounds, especially in the UK, but this has not had any measurable impact on wild populations (White *et al.,* 2003). This is now illegal in the UK.
Effort required e.g. period of time over which measure need to be applied to have results	Although hunting with firearms requires little equipment, hunting with hounds would require a high degree of institutional infrastructure in order to maintain trained packs of dogs etc. and overturning legislation in the case of the UK.
Resources required [1] e.g. cost, staff, equipment etc.	Infrastructure to establish and develop hounds, and the staff that goes with this. This is difficult to estimate.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Hunting both with firearms and dogs – if allowed, would create general disturbance to other wildlife species.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Hunting with hounds is likely to raise significant concern from stakeholders, which was the reason for the original ban in the UK, due to its perceived lack of humaneness. Hunting with firearms would require significant risk assessments and stakeholders may not find the risks acceptable.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States	No information available.

- the cost of inaction - the cost-effectiveness - the socio-economic aspects	
Confidence	**High,** Hunting, especially with hounds, has been well researched.

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See guidance section

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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 solely 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)