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 species under review. Each table represents a separate measure.

Species (scientific name)	*Alopochen aegyptiaca* (Linnaeus, 1766)
Species (common name)	Egyptian goose
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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.

To *prevent the introduction* of new Egyptian goose (*Alopochen aegyptiaca*) populations, a ban on keeping, importing, selling, breeding and growing these birds as required under Article 7 of the IAS Regulation, including in zoos and private collections is the most cost-effective method. *Early detection* can best be achieved by further empowering citizen-science networks. A smart integration of data flows from citizen-scientists and regular bird monitoring

programs will be key to ensure that information on newly detected invasive populations is timely transmitted to the authorities responsible for *rapid eradication*. The most cost-effective solution to such eradication is a combination of bird trapping using Larsen-traps with decoy birds and direct shooting of birds. As shooting requires a good knowledge of the local habitat and may require extensive coordination, Larsen traps are likely to be more cost-effective at this stage. The reverse is true for *managing* the often large populations already present in several EU member states. Available evidence suggests that hunting can potentially stabilize the populations and/or reduce them to acceptable levels. Larsen traps can contribute to population reductions mainly in areas where hunting is not possible because of e.g. public safety or because of disturbance effects on non-target species. Methods often used to manage other invasive geese (egg oiling, trapping during the moulting period) are not cost-effective to provide the main management methods for Egyptian geese. While the available literature allows the ranking of the (cost-) effectiveness of different techniques with a reasonable degree of confidence, it remains difficult to translate this to actual cost estimates (in terms of funds needed for material and staff). This is because such information is typically not publicly reported and Egyptian goose management is often coordinated by local (subnational) government bodies. More detailed inquiries targeted at administrative units that are responsible for Egyptian goose eradication or management will likely shed more light on the actual cost of coordinating and carrying out these actions.

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** as required under Article 7 of the IAS Regulation. The restrictions under Article 7 of the IAS Regulation are applicable since 2 August 2017. Transitional measures for commercial and for non-commercial owners are provided for in the Regulation. Egyptian goose have been introduced in Europe because of their ornamental value (pet trade), and escapes or releases from zoos or private collections have formed the main pathways of introduction in Europe (Lever, 2005).
Effectiveness of measure e.g. has the measure previously worked, failed	Banning Egyptian geese in private or zoo collections **may help preventing the occurrence of new breeding populations** of the species in member states where it is currently absent. No specific information exists on how banning Egyptian goose aviculture would translate into changes in invasion risk, but it is generally recognized that 'propagule pressure' (a measure of the number of individuals released into the wild and the number of release attempts) is a strong predictor of invasive bird invasion success (Blackburn *et al.*, 2015). Specifically for ornamental and pet birds, escapes from zoos or private collections are an important source of invasive species (Cassey and Hogg, 2015).
Effort required	The ban needs to be in place **permanently.**

e.g. period of time over which measure need to be applied to have results	
Resources required [1] e.g. cost, staff, equipment etc.	**Unknown**. The main resources for a ban on Egyptian goose in zoos and as pet birds relate to *staff* cost for implementing and enforcing this ban. It is thought unlikely that this requires additional staff for the government administrations that are typically responsible for such enforcements (see below for information of prevalence of Egyptian goose in European collections).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	There are **likely negative economic effects** for those companies or persons involved in keeping, breeding and/ or showcasing Egyptian geese. Banning species from trade typically results in some economic losses (Springborn *et al.*, 2015), although these are likely minor in the case of Egyptian geese. This is because *(1)* the Risk Assessment mentions that the number of specimens kept in European zoos is low, and *(2)* although the number of birds in private collections may be higher, there is little evidence that the Egyptian goose currently is a very common bird in private collections. There is little empirical data on the trade in Egyptian goose, targeted Google searches on some of the main bird trading websites/bird keeping societies yield very little information on the availability of captive individuals (pers. obs. D.S.). Similarly, queries on the CITES database for the EU during the period 2005-2016 did not return any trade in live Egyptian geese. Current European Egyptian geese populations seem to largely stem from historical releases during a time period when the species was a more popular ornamental bird.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Given the (apparently) low number of people involved in Egyptian geese trade, acceptability of a ban will likely be high.
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	**No additional costs known.**
Level of confidence [2] See guidance section	**High** for the effectiveness of banning the species to prevent new introduction events. **Medium** for the cost-effectiveness of the measure, as it is possible that internet-only searches may underestimate the prevalence of this species in the ornamental bird trade.

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	**Online citizen-science databases.** Citizen-science species occurrence datasets are increasingly recognized as a valid tool for monitoring the occurrence and spread of invasive species across large spatial and temporal scales (Roy *et al.*, 2015). There are a wide-range of international (e.g. eBird, GBIF, observation.org, iNaturalist) and country-specific (e.g. BirdTrack, DOFbasen, Cuaderno de Aves Exoticas) data portals that are currently already operating and that contain real-time data on invasive species occurrence, including the Egyptian goose. Some of these programs run special 'invasive species' subsections, where the (often large) base of citizen-scientists are provided with a background to invasive species (e.g. species identification, brief summary of associated threats), are invited to pay special attention to the species and to upload any observations of these species (e.g. see the Belgian waarnemingen.be for an example including the Egyptian goose). These databases are typically operated by nature-conservancy NGOs, although some are owned by government administrations or even private individuals. They are dependent on citizen-scientists who collect and upload data, and the majority of data are gathered through so-called 'opportunistic sampling', meaning that there is no underlying scientific survey design (Boakes *et al.*, 2010).
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	**Successful use of citizen-science databases**. There are no concrete examples where these databases have been used for early detection and rapid eradication specifically for Egyptian geese, but examples abound for other taxa. For example, for the UK, a review by Roy *et al.* (2015) concluded that the volunteer recording community is already a major and crucial contributor to the monitoring and surveillance of invasive species. A concrete example comes from the marine realm, where Scyphers *et al.* (2015) report that citizen-observation schemes documented the occurrence of non-native lionfish 1-2 year earlier than traditional monitoring programs. Although not specifically document, the same is likely to be true for birds. The most relevant example of the use of citizen-science data in the context of this report comes from Belgium, where a range of online data portals, smartphone apps and direct mailings to volunteers was used to alert conservation managers to the occurrence of the invasive ruddy duck (*Oxyura jamaicensis*). Reported occurrences were then used to inform a 'rapid-response', whereby government administrations worked together with volunteer hunters to remove at least 70 individuals since 2009 (Adriaens *et al.*, 2017). **Limitations of citizen-science databases.** Citizen-science datasets are characterized by strong spatial and taxonomic biases (Geldmann *et al.*, 2016), while the lack of underlying scientifically-validated sampling design can limit the conclusions that can be drawn from these data (Isaac *et al.*, 2014). In the context of this review, the *spatial bias* is most important. Whereas structured

	monitoring programmes can implement a range of sampling strategies to ensure sufficient detection probability across a given area, citizen-science data are wholly dependent on where volunteers chose to go. These are typically areas that are easy to reach, are closer to human population centres and/or are characterized by a high biodiversity/presence of rare or charismatic species (Isaac *et al.*, 2014; Geldmann *et al.*, 2016). This may lead to a delay in detecting a new presence of the species. Whereas Egyptian geese were first introduced into urban city parks, they are currently spreading into agricultural areas where citizen-science based detection probabilities are likely lower. In addition, whereas at least for birds, most parts of north-west Europe have an extensive network of volunteer observers, coverage and survey intensity likely is significantly less in southern and especially eastern Europe (Boakes *et al.*, 2010). Unstructured citizen-science data do not reliably allow the estimation of species abundance or population trends (Kamp *et al.*, 2016), yet in an early-warning scenario it is likely sufficient to know where a species is establishing, and these data limitations are thus of a lesser concern.
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	Little information is available on the survey intensity required to detect Egyptian geese when present. A lower bound is likely set by Chesbro (2015), who surveyed a small, low-density population of non-native Egyptian geese in Arkansas, USA and found a relatively low detectability of 34.4%. Following Kéry (2002), this implies that seven site visits are needed before it can be concluded with 95% confidence that the site is not occupied by Egyptian goose. The lower detectability was attributed to the general low population density of the species in the area, the fact that surveys were carried out during the breeding season (breeding birds are more difficult to observe) and difficult access to sites such as farmponds or open areas where sight was blocked by trees or man-made structures. Integrating such detectability estimates with data on the number of times a certain area is visited by citizen scientists allows the creation of spatially-explicit maps showing where the species is likely to be detected when present, and which areas are likely under surveyed.
Resources required [1] e.g. cost, staff, equipment etc.	Resources required relate to **ensuring access to citizen-science databases** and to **staff to manage and integrate different data flows**. Gaining (timely) *access* to the different national and international databases operated even in a single member state typically needs to be negotiated on a case-by-case basis. While some platforms allow for free and open-data sharing, others charge for access to data. For example, NGOs typically charge funds to cover expenses related to organizing and informing their volunteer base, maintaining Information and Communication Technology (ICT) infrastructure and the implementation of data quality procedures. Preliminary inquiries made to some of the main north-western European NGOs operating citizen-science data did not immediately results in cost estimates, as more specific information is required for obtaining a quote (e.g. yearly reporting of data versus real-time access, issues related to the fact that not all

	observers or area owners/managers automatically allow for data sharing, etc.). The cost of obtaining some of the more expensive citizen-science data, namely bird ringing recovery data, can be illustrated by the costs advertised by the Dutch ringing centre (available here). Costs for non-volunteer/non-academic data use were most expensive and ranged from € 1,382 for up to 10 ringing recoveries to € 8,289 for > 1,000,000 recoveries. While tentative, the cost of obtaining data on early establishment data of Egyptian geese are unlikely to exceed such a price range. The other main cost related to the use of citizen-science data as early-warning system are ***staff costs*** to integrate and summarize data flows from different platforms and schemes. Obviously, some staff needs to be responsible for aggregating data on Egyptian geese occurrence, and liaising with a 'rapid response' team when data flows suggest that species' establishment is likely. No estimates of how much human resources would be needed for coordinating such an early-warning system for Egyptian geese only were found (it seems more logical to create positions for monitoring a set of comparable species rather than for this species only). The most concrete information found in the literature pertains not to an early warning system, but to a Belgian report exploring feasible options for removing Egyptian geese from the wild (INBO Partner Report, pers. comm. Tim Adriaens). In this 2012-2014 project, a total of 860 trapping days were deployed in 19 locations across the western part of Flanders (approximately 6,200 km^2), and scientific coordination required a 0.5 FTE (Full Time Equivalent) for a research assistant plus 0.25 FTE scientist time (INBO Partner Report, pers. comm. Tim Adriaens). Monitoring an early-warning system only will require less efforts, so these estimates can be used as a basis for estimating an upper boundary to human resources needed for a member state.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	**None known**.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	**Acceptability risks**. Management of charismatic invasive species such as most birds may be met with opposition from the general public (Crowley *et al.*, 2017a). Using citizen-science data as early-warning system is unlikely to generate such opposition, but anecdotal evidence suggests that some negative reactions can arise when actual management is initiated. For example, when the ruddy duck (*Oxyura jamaicensis*) eradication campaign was started in the UK, messages were posted on several 'birder' internet asking volunteers not to share data on ruddy duck occurrence because they would be used for targeting the birds (pers. obs. D.S.). The same has been reported from the Netherlands (Schneeweizs, 2017).

	Acceptability opportunities. Involving citizen-scientists in monitoring of invasive species presents an opportunity to inform the general public on the phenomenon, and on why management actions against invader are warranted (Bonney *et al.*, 2009; Crowley *et al.*, 2017b).
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	Apart from the costs related to obtaining access to data and staff costs to manage data flows, there are unlikely to be additional implementation costs. Use of citizen-science data as invasive species early-warning is generally recognized to be a cost-effective monitoring strategy (Roy *et al.*, 2015). Estimates of the cost of inaction (i.e. failing to prevent the establishment and subsequent spread of invasive Egyptian geese) are detailed in the species' Risk Assessment.
Level of confidence [2] See guidance section	**High** for both the efficiency and the cost-effectiveness of using citizen-science data in most of Europe, but **medium** in parts of southern and eastern Europe where citizen-science engagement is lower.

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	**Regular bird species monitoring schemes.** All EU member states operate standardized bird population monitoring schemes, often in order comply with national or supranational (e.g. EU Bird and/or Habitat Directives) reporting requirements regarding the state of environment. Although spatial coverage, methodology and avian taxa surveyed may differ between countries, these schemes have in common that they are based scientifically-validated sampling protocols (in contrast to the unplanned and opportunistic sampling obtained by citizen-science data). Just as the above mentioned citizen-science data sources, these schemes are already operating and depending on their focus, they are also likely to contain data on invasive Egyptian goose occurrences.
Effectiveness of the surveillance	The use of regular bird monitoring schemes as early-warning system has strong similarities to the

e.g. has the surveillance previously worked, failed	description for citizen-science data, but there are both advantages and disadvantages. **Advantages of bird monitoring schemes** include the fact that many of these schemes have specifically been designed to ensure a representative cover of member states, and are thus much less prone to the spatial surveyor biases characteristic for unstructured citizen-science data (Jiguet *et al.*, 2012). Underlying sampling designs also more readily allow the estimation of species' abundance and population trends, which can be used to determine whether Egyptian geese are establishing self-sustaining populations with a higher degree of confidence. As these schemes are typically (at least partly) funded by governments, it is likely easier to negotiate or demand the inclusion of Egyptian geese in the monitoring (if not already present). Lastly, these data are already available to government administrations and do not need to be purchased from third parties. The use or regular biodiversity monitoring for early detection of invasive species is well-recognized (Hulme, 2006; McGeoch *et al.*, 2011). **Disadvantages** include the fact that while these schemes typically have a more representative spatial coverage, their sampling is less 'dense' (i.e. a lower number of sites are monitored; for example, a main French monitoring programme, the FBBS (Jiguet *et al.*, 2012), yields yearly data on bird species abundance for 2,133 2x2 km sites across the whole of France, corresponding to only 1.33% of the country's territory). The temporal resolution is also lower compared to unstructured citizen-science data, as bird surveyors are typically instructed to sample birds at best a few times per year (e.g. the French FBBS requires two site visits during spring). Schemes are not necessarily annual, for example, the Flemish common breeding bird survey monitors 1,200 1x1 km sites on a three-yearly cycle (Vermeersch *et al.*, 2007). Recent analyses suggest that the best surveillance results can be obtained by integrating regular monitoring schemes with unstructured citizen science (Giraud *et al.*, 2016), although it should be noted that such analyses can be complex and necessitate statistically skilled scientists.
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	Similar as for the unstructured citizen-science data mentioned above. The fact that regular bird monitoring schemes are based on scientifically sound sampling schemes should allow to determine required survey efforts with higher confidence.
Resources required [1] e.g. cost, staff, equipment etc.	As governments typically fund (at least part) of the costs of setting up and operating regular bird monitoring schemes, data are already available to administrations and the only costs are staff costs to integrate data flows from different (unstructured and regular) schemes. The estimate of staff costs mentioned above should already allow for including data from regular schemes (if the scientists employed have adequate statistical experience).
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	**None known.**

Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Same as for unstructured citizen-science data, see above.
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	Same as for unstructured citizen-science data, see above.
Level of confidence [2] See guidance section	**High** for both the efficiency and the cost-effectiveness of using regular bird monitoring data.

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	**Trapping using floating or land-based Larsen traps.** A Larsen trap is an (often transportable) cage with a spring activated trap door at the top or side that will close behind any bird heavy enough that enters the trap. A previously captured Egyptian goose is placed in the decoy compartment, and this attracts other birds. The trap can be baited with food to enhance trapping chances. Technical information on Larsen traps tailored to Egyptian geese can be found in Van Daele *et al*. (2012, see Figs 5.1 to 5.4) and in the INBO Partner Report (pers. comm. Tim Adriaens). Larsen traps need to be inspected at least on a daily basis to control whether Egyptian geese or non-target species were caught. Larsen traps can be land-based or used on floating devices.
Effectiveness of measure e.g. has the measure previously worked, failed	Larsen traps **have proven effective in removing small, emerging breeding groups** of Egyptian geese in parts of Belgium (INBO Partner Report 2014). A trial at 27 different locations showed that over 1 to 9 days (total number of catching days: 89), land-based Larsen traps were able to remove all breeding birds from an area (where typically one to two breeding couples were present). There is evidence that land-based Larsen traps are more successful than floating traps. Another trial where floating Larsen traps were used (19 locations, 860 trapping days in total) was able to remove 80 Egyptian goose from the wild, but whereas Egyptian geese were caught in all 27 land-based

	Larsen traps, only 15 out of the 19 floating Larsen traps were successful (INBO Partner Report 2014). When expressing effectiveness as the number of Egyptian goose caught per trapping day, land-based traps yield an average of 0.7 animals/trapping day while floating traps only reach 0.09 geese/trapping day.
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	A field trial conducted in 27 locations across the western part of Belgium showed that a single land-based Larsen trap was able to remove all breeding pairs present (typically one or two couples) within a time-span of 1 to 9 days. A rough rule of thumb based on the data (INBO Partner Report) indicates that land-based Larsen traps with decoy Egyptian geese present can allow to catch about 0.7 Egyptian geese per day per trap.
Resources required [1] e.g. cost, staff, equipment etc.	Main expenses relate to **material to build Larsen traps** and to **staff** costs. There are no commercially available Larsen traps for this species, but these cages can easily be constructed by skilled technicians using standard construction materials such as shuttering plywood, wire netting and floating devices (for water-based traps only). The number of traps needed will depend on the number of locations where geese are detected, but given the relatively short trapping period needed (1 to 9 days to remove breeding birds, INBO Partner Report), re-use of traps is likely possible in case of multiple incursions. As traps need to be inspected daily (to check for any animals caught, to ensure the welfare of the decoy bird, and renew bait), the main costs will relate to **staff**. The number of staff needed will depend on the number of locations that where traps need to be placed and how far these sites are spread from each other. The Belgian case study (INBO Partner Report, 19 locations relatively close to each other, max distance between two sites < 120 km) employed 2 FTE field control officers for their project, and it can thus be assumed that if capture sites are not too spread out, 1 person can manage about 10 Larsen trap inspections/day.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	**Negative**. Larsen traps are not able to discriminate between Egyptian geese and other species of similar or larger body weight, and will inevitably result in some bycatch. For example, when using floating Larsen traps, over a period of in total 860 trapping days, 80 Egyptian geese and 68 non-target species (including 17 non-target invasive bird species) were caught during a Belgian field trial (INBO Partner Report 2014). These non-target species can be released back into the wild (unless there are specific reasons no to do so, e.g. when they belong to another non-native species).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	There is a certain risk that **traps will be vandalized and/or birds will be set free deliberately**. Such risks can be minimized by using less accessible floating Larsen traps, and/or by providing information and guidance to the general public in areas where the traps are operated. General guidelines for reducing public opposition to such projects is available (Clarin *et al.*, 2014). In the Belgian field trials, no vandalism was reported but more information is needed should the method be employed on a larger scale or in more urban areas.
Additional cost information [1]	**(1) Transport costs.** Larsen traps need to be inspected on a daily basis, so there are car and

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	gasoline costs that need to be taken into account as well. This cost will obviously depend on the number of traps to be visited and their spatial positions. **(2) Euthanasia of trapped geese**. After catching, Egyptian geese need to be euthanized by a licenced person using accepted methods. I was not able to find estimates of these costs but they should be considered as well for estimating the total cost of managing Egyptian geese using Larsen traps.
Level of confidence [2] See guidance section	**Medium.** The Belgian field trials were effective and promising, but this approach is assessed as medium as 1) there is currently no information on the effectiveness of these techniques in other populations/habitats, 2) it remains unsure to what extent the placing of Larsen traps can be upscaled and managed across larger spatial scales.

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	**Shooting.** Shooting of emerging populations by professional marksmen or through encouraging existing hunters.
Effectiveness of measure e.g. has the measure previously worked, failed	Long (1981) mentions that the shooting of breeding birds at least temporarily halted the establishment of Egyptian geese in Britain and the USA. However, no more specific information is provided and the examples given are historical (1977, before 1920) and may be of little relevance for contemporary invasions. Shooting is now primarily used for managing Egyptian geese populations, rather than eradicating them (see below, management). Shooting is however considered the most (cost)-effective measure to eradicate the ruddy duck (*Oxyura jamaicensis*, Smith et al. 2005). Currently, the UK ruddy duck population is reduced to a number of small, independent populations that due to their migratory behaviour can occur in unexpected places throughout the UK - a situation similar to the early-establishment phase. It is useful to note that also in this stage, shooting remains the preferred and most-cost effective action (Henderson 2006).
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	**Unknown**. Some information can be gleaned from a Belgian project whereby hunting was one of the strategies to manage a set of non-native geese species (Van Daele *et al.*, 2012). The project applied both volunteer hunters and professional marksmen and tentatively concludes that the effort required for targeted hunting is likely to be 'substantial' because of the preparations involved. Effective, targeted shooting necessitates skilled hunters, a good knowledge of the area in which the hunting will be done, needs to consider possible effects on non-target species as well as address public safety issues (Van Daele *et al.*, 2012).
Resources required [1]	**Unknown**, but main costs will relate to (1) *staff* to coordinate such an eradication campaign, (2)

e.g. cost, staff, equipment etc.	payments to professional marksmen involved. The above-mentioned Van Daele *et al.* (2002) report does not mention total cost, nor does it provide information on the relative cost-efficiency of using volunteer hunters versus professional marksmen. In contrast, it mentions that the trials performed so far are still too limited in scope to make a meaningful analysis of their cost-efficiency. Some estimates may be gleaned from the Belgian attempts to eradicate the ruddy duck (Adriaens *et al.*, 2017). This campaign necessitates the coordination of a steering group with representatives of all stakeholders (government representatives, area owners and/or managers, hunting organizations, nature-conservancy NGOs ...). The 2016 estimated maximum number of ruddy duck remaining in Belgium was 32 birds, and a tender announced for the eradication of ruddy duck gave a budget of € 6,000 for the period 2017-2020 (Adriaens *et al.*, 2017).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Negative (disturbance) effects on **non-target fauna** needs to be considered, as well as public safety. However shooting by professional marksmen has been used to remove the ruddy duck from the UK without significant issues of disturbance or public safety.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Egyptian geese **are currently already hunted** in the European countries where they occur, and the use of shooting to prevent their establishment will likely be as acceptable. As before, informing the general public about shooting emerging Egyptian goose populations is crucial for minimizing public opposition. It should be noted that hunting typically is not allowed (e.g. because of public safety) in urban areas, where public opposition to eradication campaign likely is highest although professional marksmen have been used in urban areas for the removal of the ruddy duck from the UK. Hunting can have shortcomings when the aim is the rapid removal of a species as hunters may see an incentive to maintain or even spread the species to increase their hunting opportunities. This shortcoming does not apply to the use of professional marksmen.
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	**No additional costs known.**
Level of confidence [2] See guidance section	**Low to medium.** Low: the only references to hunting as an eradication strategy to prevent Egyptian geese establishment come from old and verbatim accounts, with little or no detail. Similarly, as for other non-native geese, most literature reports refer to hunting as management, rather than a rapid response eradication strategy. Medium: Given that organised shooting using professional marksmen has been successfully used as the main method for the removal of the ruddy duck from

	the UK, it is likely that a similarly professionally coordinated campaign would be effective in removing Egyptian geese as well.

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/shooting**. As the Risk Assessment mentions, Egyptian geese are currently already hunted in the UK, the Netherlands, Belgium, Germany and Denmark. Hunting strategies may differ between countries and habitats.
Effectiveness of measure e.g. has the measure previously worked, failed	**Likely effective**. While several countries allow Egyptian geese to be managed by shooting, there typically is no requirement to report on the number of birds shot (e.g. as under the UK General Licence, here), making it difficult to assess the effectiveness of shooting as a management policy. The best evidence on shooting effectiveness comes from the Netherlands (where reporting on shot birds is mandatory, Visser *et al.*, 2015). Gyimesi and Lensink (2012) used demographic models to assess the feasibility of population management of shooting to control Egyptian geese numbers and found that about 28% of the population needs to be annually culled to prevent the populations from growing, and credited culling by shooting as a main reason behind the (near) stabilization of the Dutch Egyptian goose population. Visser *et al*. (2015) report a very high shooting effectiveness for Egyptian geese in the Zuid-Holland region. This region conducts annual counts of the likely number of Egyptian geese present and the number of birds shot, and finds that > 100% of the birds present are shot each year (this discrepancy is caused by counts that underestimate the true number of Egyptian geese present, or migration of Egyptian geese to the Zuid-Holland region after the counts have been conducted). Indeed, counts show that whereas Egyptian geese populations continue to grow at the national level, the Zuid-Holland estimates indicate a continuing decline from 4,115 birds in 2007 to 1,559 in 2013 (Visser *et al.*, 2015).
Effort required e.g. period of time over which measure need to be applied to have results	**Unknown**. As this is a management strategy, continuous shooting will be necessary to reduce population growth and limit population size to 'acceptable' levels. Gyimesi and Lensink (2012) estimate that yearly, about 30% of the populations should be culled to stabilize their numbers.
Resources required [1] e.g. cost, staff, equipment etc.	**Unknown**. Hunting of Egyptian geese is typically coordinated at lower administrative levels (counties, provinces or even city-level), and whereas there is some information about the number of Egyptian geese shot, reports typically do not mention the number of people involved (hunters, government personnel, area managers, etc.). There are no readily available estimates of the number of hunters involved in Egyptian goose hunting, nor the hunting effort that is needed to reduce Egyptian goose populations.

Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	**Disturbance of non-target species**. Hunting risks disturbing non-target species and may not be acceptable in certain areas (such a nature reserves or Natura 2000 sites). **Public safety**. Because of safety, hunting is (almost) never allowed in urban areas. It should however be noted that in the UK, the use of professional marksmen (in contrast to volunteer hunters) did allow for shooting ruddy ducks at nature reserves and in urban area too (Henderson 2010).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Shooting of Egyptian geese is likely to and has indeed already resulted in **public opposition**, mainly from animal rights activists (Langers *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	**No additional costs known.**
Level of confidence [2] See guidance section	**Medium.** There is both theoretical and empirical evidence that shooting by hunters can help stabilize Egyptian geese numbers (Gyimesi and Lensink, 2012; Visser *et al.*, 2015). Yet, most (well-documented) studies pertain to subnational regions only, and while regional decreases due to shooting can reasonably be argued for, at the national level, Egyptian geese populations are still increasing and it is thus not clear whether hunting pressure can be upscaled to larger spatial scales.

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	**Egg oiling** is a form of management in which bird eggs are coated with mineral or corn oil, preventing gas exchange through the shell and killing the embryos. The eggs are treated and replaced so that the female goose continues to incubate in a futile attempt to hatch the eggs.
Effectiveness of measure e.g. has the measure previously worked, failed	Egg oiling is **not considered an effective measure** for the large-scale management of Egyptian geese. While this method has been successfully applied to a range of colonial-nesting, ground-breeding bird species (Van Daele *et al.*, 2012), several life-history characteristics make it difficult to apply this technique to Egyptian geese. (1) Egyptian geese often nest in inaccessible sites such tree holes, (2) Egyptian geese do not breed colonially so it is not possible to detect and treat a large number of nests/eggs. Only in **exceptional circumstances, egg oiling can contribute** to reductions

	in Egyptian geese numbers. For example, in nature reserves where hunting is not allowed because of negative effects on non-target species it may be one of the only feasible measures. In the Dutch Zuid-Holland area, the proportion of Egyptian geese nests that could be targeted in this way increased from 0% in 2008 to 11% in 2013 (Visser *et al.*, 2015). Around Schiphol airport, up to 19% of Egyptian goose nests could be targeted in 2013 (Visser *et al.*, 2015).
Effort required e.g. period of time over which measure need to be applied to have results	**Unknown but likely substantial**. Egyptian geese do not breed colonially, sometimes nest in inaccessible sites and can be difficult to detect during the breeding season (Delcroix, 2013). Detecting and treating a number of nests sufficiently large to influence populations will likely be substantial. Detailed population demography modelling can be undertaken to quantify the number of nests that need to be treated to dent population growth.
Resources required [1] e.g. cost, staff, equipment etc.	**Unknown but likely substantial**. Both food-grade corn oils, paraffin and a range of other oils can be used and material costs are likely minor. Yet, finding, treating and monitoring nests will be labour-intensive. There are no available estimates of the resources or costs needed for treating Egyptian geese in Europe. The only concrete costs are older estimates for treating Canada geese (*Branta canadensis*) nests in the USA, where Baker *et al*. (2008) state that 'Overall costs for these methods may be as high as $40 per egg treated (Keefe 1996) but would be lower in high density nesting areas.'
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	**No side effects known.**
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	This method is considered to be **among the most humane and widely accepted** methods for managing birds (Raj, 2008).
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 stated above, the measure is likely not to be cost-effective and is to be considered as on option only in areas where most effective methods such as trapping or shooting are not possible.
Level of confidence [2] See guidance section	**High.**

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 using floating or land-based Larsen traps.** See above ('Rapid eradication' section) for description of technique.
Effectiveness of measure e.g. has the measure previously worked, failed	As described above, this technique seems primarily suitable for rapid eradication of small, emerging populations but **may also be useful as a management method** where shooting is not possible. While the efficiency of floating Larsen traps seems to be rather low (on average, only 0.09 Egyptian goose per trap per day), land-based Larsen traps were able to capture about 0.7 Egyptian geese per day (INBO Partner Report). While this is probably not sufficient for ensuring the removal of very large numbers of birds from the wild, a set of strategically placed Larsen traps is likely to be able to catch several tens to hundreds of birds over the course of a year.
Effort required e.g. period of time over which measure need to be applied to have results	**Unknown**. As Van Daele et al. (2012) notes, trials conducted so far give a reasonable indication about which methods that are likely to be most effective in managing or eradicating Egyptian geese, but do not allow to formally rank them according to cost-effectiveness or to tabulate likely total costs for Egyptian geese management actions. Smith et al. (2005) warns against a naive upscaling of data such as those presented by Van Daele *et al.* (2012) and the INBO Partner Report (2014) to larger spatial scales, for example because of important but difficult to quantify effects such as reductions in culling efficiency associated with declining population size, possible seasonal differences in ease of trapping and animal learning behavior leading to increased trap shyness. Smith et al. (2005) applied statistical modeling combined with targeted control trials to be able to inform funding bodies about the cost and outcome of different eradication strategies with a high degree of confidence, and a similar study should be prepared for Egyptian geese in order to adequately answer questions on the efforts and resources required for managing/eradicating Egyptian geese.
Resources required [1] e.g. cost, staff, equipment etc.	**Unknown**, please see above (section 'Effort required').
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	See above ('Rapid eradication' section).

Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	See above ('Rapid eradication' section).
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 ('Rapid eradication' section).
Level of confidence [2] See guidance section	**Medium.** While the Larsen-traps have been successfully used to remove small, emerging goose populations in a set of test locations, it remains unsure how cost-effective they will be when employed on a much larger scale.

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	**Capture during the moulting period**. During the moulting period, several goose species become flightless or at least severely limited in their flying capability. During this period, large groups of geese can be driven together and channelled towards a special built funnel systems in which they become trapped (Van Daele *et al.*, 2012), and from which they can then easily be collected for euthanasia. This typically involves the use of small boats or kayaks as the animals typically seek refuse on the water when they are being driven towards the funnel system (Van Daele *et al.*, 2012; Delcroix, 2013).
Effectiveness of measure e.g. has the measure previously worked, failed	This method is **unsuitable** for the catch of Egyptian goose because (a) they do not become completely flightless during the moulting period (in contrast to for example the Canada goose), and (b) more importantly, Egyptian goose are excellent diving birds and typically dive underwater to prevent being forced into the funnel system. See Van Daele *et al*. (2012) for studies experimenting with but deciding against the use of this technique for Egyptian goose.
Effort required e.g. period of time over which measure need to be	N.A. – this method is mentioned because it is a popular and effective method for managing other invasive geese, but literature strongly suggests it is not suitable for the Egyptian goose.

applied to have results	
Resources required [1] e.g. cost, staff, equipment etc.	N.A. – this method is mentioned because it is a popular and effective method for managing other invasive geese, but literature strongly suggests it is not suitable for the Egyptian goose.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	N.A. – this method is mentioned because it is a popular and effective method for managing other invasive geese, but literature strongly suggests it is not suitable for the Egyptian goose.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	N.A. – this method is mentioned because it is a popular and effective method for managing other invasive geese, but literature strongly suggests it is not suitable for the Egyptian goose.
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	N.A. – this method is mentioned because it is a popular and effective method for managing other invasive geese, but literature strongly suggests it is not suitable for the Egyptian goose.
Level of confidence [2] See guidance section	N.A. – this method is mentioned because it is a popular and effective method for managing other invasive geese, but literature strongly suggests it is not suitable for the Egyptian goose.

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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)