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

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

Species (scientific name)	*Asclepias syriaca* L., Sp. Pl. 1: 214. 1753
Species (common name)	Common milkweed, butterfly flower, silkweed, silky swallow-wort, Virginia silkweed
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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.

The species *Asclepias syriaca* (common milkweed), native to North America, is a perennial plant that originally occurs in disturbed areas and early successional habitats (Züst, Rasmann, & Agrawal, 2015). *A. syriaca* reproducing both asexually by underground rhizome-like stems and sexually by flowers (Broyles, Vail, & Sherman-Broyles, 1996; Csontos, Bózsing, Cseresnyés, & Penksza, 2009; Züst et al., 2015). A milky white latex functions as mechanical defence against herbivores (Ducs, Kazi, Bilko, and Altbaecker, 2016). After the species was introduced for ornamental purposes in the early 18th century (Gaertner, 1979), *A. syriaca* invaded European ecosystems, mainly in Hungary, Romania and Poland (Botta-Dukát and Balogh, 2008; DAISIE, 2017; Rutkowski *et al.,* 2016; Zimmermann, Loos, von Wehrden, and Fischer, 2015). Currently the species is recorded as naturalised or established in 23 courtiers in Europe (Tokarska-Guzik and Pisarczyk, 2015). In warmer areas of southern Europe the species is categorised as invasive (Bagi, 2008; Tokarska-Guzik, Barbara Pisarczyk, 2015). *A. syriaca* is establishing in semi-arid ecosystems, e.g. degraded forests and dry grasslands, where it is outcompeting native plant species and influencing the native fauna (Gallé, Erdélyi, Szpisjak, Tölgyesi, and Maák, 2015; Züst *et al.,* 2015). The species *A. syriaca* currently occurs in Europe in the following habitats: wastelands, oat cultivations (Poland), urban habitats (Poland, Hungary, Netherlands), dune habitats (Netherlands, Poland), railways, ditches, roads and agroecosystems, e.g. vineyards (Slovakia, Poland, Netherlands, Croatia) and natural and semi natural grasslands (Slovakia, Croatia, Hungary, Poland) (Bagi, 2008; Botta-Dukát and Balogh, 2008; Matthews *et al.,* 2015; Pauková, Káderová, and Bakay, 2013; Rutkowski *et al*., 2016).

<u>Prevention</u>

Two prevention measures were identified. Firstly, the intentional introduction on all specimens of *A. syriaca* is prevented through a ban on keeping, importing, selling, breeding and growing as required under Article 7 of the IAS Regulation. Although *A. syriaca* is known as invasive it is still commonly used for ornamental horticultural purposes. The second prevention measure is addressing pathways of unintentional introduction and spread.

<u>Early detection</u>

Visual detection is considered to be the only way to assess the species occurrence in early stage. The measure requires trained staff and knowledge about potential locations of the species occurrence. Further, regular monitoring of degraded areas within protected areas can help to detect the early invasion of sensitive areas by the species.

<u>Rapid eradication</u>

The selective spraying of herbicides can be used in non-crop areas and protected areas. The measure is cost efficient and effective in the short term. Manual and mechanical control, e.g. cutting or manual harvesting, is efficient in the early stage development of the individual plant, before the roots Anker the plant strongly to the soil. Any mechanical removal measure creates a disturbance to the vegetation cover, which is likely to be reinvaded.

<u>Management</u>

By mowing or cutting (mechanical control) the distribution of seeds can be limited. This highly time- and labour-consuming measure requires an application in the long term. Since *A. syriaca* is invading agricultural land (crop fields) various cultural control measures were developed to limit the

growth of *A. syriaca*. This includes adaptation of crop rotations, plantation of competitive crop. Moreover, the use of chemical control is a cost-efficient measure in large area, e.g. crop fields. This measure negatively affects native species and the local environment. The logistically challenging adaptation of road side management can be taken under consideration, when stands of *A. syriaca* are observed along roads, which are known as a potential pathway of the invasive species. Finally, most experts come to the conclusions, that it is more effective and cost efficient to combine mechanical control and selective chemical control measures (Ducs *et al.*, 2016; Kelemen *et al.,* 2016; LIFE06 NAT/H/000104, 2014). The integration of control and eradication measures are more likely to success if they are implemented in a long-term monitoring.

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 is required under Article 7 of the IAS Regulation.** Common milkweed (*A. syriaca*) is native to eastern North America and has been repeatedly introduced to southern and central Europe since the 17th century (Gaertner, 1979), also as a crop. In the past *A. syriaca* was used also for the production of fibre, similarly to other *Asclepias* spp. Today *A. syriaca* is cultivated as an ornamental plant and as a honey plant (by beekeepers). The species is particular popular, because of its attraction of butterflies (Van Vleet, 2017). Twenty seeds can be purchased online for 1.50 EUR (Van Vleet, 2017). The ornamental horticultural industry is a significant pathways and *A. syriaca* might easily escape from cultivation. Implementation of these restrictions for preventing intentional introductions requires a strategy that includes harmonisation of international standards, and the identification of pathways of import and trading (Burgiel et al., 2006). In addition awareness raising activities, which can be supported by various information tools, e.g. online and print media, would complement this measure. It is important to identify and provide the relevant stakeholders with invasive species identification skills (Stokes et al., 2006).
Effectiveness of measure e.g. has the measure previously worked, failed	The effectiveness of legal restrictions as required under Article 7, decreases if the species is already established in the country (Dehnen-Schmutz and Touza, 2008). The long term success of such a ban is influenced by the species identification skills of relevant staff and authorities. The effective implementation of a ban requires the integration of the prevention measure with horticultural

	trade objectives, governments, industry and civil society at the national, regional and international levels (Burgiel et al., 2006).
Effort required e.g. period of time over which measure need to be applied to have results	. The restrictions would need to be in place permanently.
Resources required [1] e.g. cost, staff, equipment etc.	In general costs include expenses for implementation of the regulation, modification of national legislation and training of the executive staff. The implementation and monitoring of these prevention measures requires interdisciplinary expertise. Moreover the procedure requires the development of technical protocols, e.g. at-border measures as well as post-entry measures (Burgiel *et al.,* 2006). The implementation of horticultural educational programmes can support the acceptance of the trade ban (Niemiera and Holle, 2009), for example promoting the use of the Council of Europe/EPPO Code of Conduct on Horticulture and Invasive Alien Plants.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Legal restrictions may lead to an increase of public awareness and education (Burgiel *et al.*, 2006). Regarding economic effects of a ban on keeping, importing, selling, breeding and growing *A. syriaca*, conflicts between private and public sectors are likely to occur (Olson, 2006). *A. syriaca* is currently present in the market as fodder crop for beekeepers and as an ornamental plant (Tokarska-Guzik and Pisarczyk, 2015). *A. syrica* has been taken into account for many bio-based uses (Spiridon *et al.,* 2016), both in the past and presently e.g. fibres for paper production (Spiridon, 2007), and phytoremediation (Stingu et al., 2012).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	No information on the acceptability of these legal restrictions on trading and trafficking *A. syriaca* is available. However, it is important to take into account that apart from its use as an ornamental species, many other uses are documented. Acceptability from stakeholder usually needs to be supported by the availability of alternatives, i.e. other non-invasive species that might provide similar services. In the US, milkweed is being grown commercially for the production of floss used as hypoallergenic fillers in pillows and comforters (Evangelista, 2007). In addition, the use of milkweed seed oil in soaps and personal care products is being explored. Thus, it cannot be excluded that there might also be European stakeholders interested in these uses.

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	Information on the additional costs of the implementation of trading bans of *A. syriaca* are not available.
Level of confidence [2] See guidance section	**Medium** Information on their effectiveness or costs is lacking.

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	**Prevention of unintentional spread of diaspores through restricting contaminated soil movements** The measure aims to prevent the unintentional spread through the movement of soil which is contaminated with diaspores of *Asclepias syriaca*. Seeds of *A. syriaca* occur within a depth of 20 cm of the surface (Yenish et al., 1996). On average, seeds remain viable (32% germination) in the soil seed bank up to four years. Common milkweed seeds require a one-year period of after-ripening before germinating. Besides contamination by seed dispersal, soil can be contaminated with root stocks, which usually develop to a depth of 100-120 cm (Bhowmik & Bandeen, 1976). Any movement of soil from sites, where diaspores of *A. syrica* occur or potentially could occur in the soil seed bank, needs to be avoided, especially if the soil is transported to, natural or semi-natural areas and agricultural land. The development of relevant biosecurity protocols (for different soil movement purposes), and possibly the establishment of certification measures is recommended.
Effectiveness of measure e.g. has the measure previously worked, failed	There is no information available on the effectiveness of these measures.
Effort required	In order for these measures to be effective the movement of the top soil layer from sites with occurrence of *A. syriaca* in the vegetation layer needs to be prevented. The entry of contaminated

e.g. period of time over which measure need to be applied to have results	soil of unknown origin can be clarified by an assessment of the soil seed bank provided by trained staff to identify 'contaminated' soil, the origin of top-soil in transport needs to be known, and any movement of top soil layers needs to be monitored. These activities will need the development of biosecurity protocols, which will need to be adopted and applied indefinitely. Public awareness needs to be created in order to avoid uncontrolled "dumping" of soil. Further the measure requires guidelines that include all involved stakeholder groups (Kerri, 2016).
Resources required [1] e.g. cost, staff, equipment etc.	There is no available information on the potential costs of this measure. In the short term an assessment methodology needs to be developed for each identified pathway (e.g. soil movement for construction purposes). For example, in horticultural and landscaping processes, humus layer are often constructed by using non-local soil. In the long term, certification systems could support the aims of this pathway management measure, which would require trained personnel to identify contaminated soil, and certify non-contaminated soil. Certifications can help to ensure that the soil is free from seeds of multiple invasive plant species. Regulations may also be needed to be developed, or adapted, to prevent the uncontrolled and undocumented movement of contaminated soil.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Once the measure is established the transported soil seed bank can be tested for other invasive species in one procedure. The successful implementation of this measure will lead to an increase of research disposals and development of treatment methods (Kerri, 2016).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	No information available. However, these measures could lead to increased costs for some sectors that rely upon the movement of soil.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction	There is no information on costs.

- the cost-effectiveness - the socio-economic aspects	
Level of confidence [2] See guidance section	**Low.** The methodology is based on theoretical concepts. Applied information or experience reports are missing.

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	**Systematic monitoring of areas at risk of invasion within protected areas.** *Asclepias syriaca* establishes rapidly when disturbance occurs in nature near grasslands (Bagi, 2008), and is known to cover large deforested and degraded areas with sandy soils (Csontos *et al.*, 2009). The monitoring of degraded areas, including that caused by human activities (e.g. construction), especially in protected areas and other important sites, is recommended as an early detection measure. Emerging seedlings of *A. syriaca* should be reported and eradicated at an early stage (Bagi, 2008; Botta-Dukát and Balogh, 2008), see tables below for rapid eradication measures.
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	The measure is known to be effective and suitable for areas, e.g. protected areas, where trained staff are available and vegetation monitoring is already established as a management activity (Botta-Dukát and Balogh, 2008). The success of monitoring programmes further depends on the inclusion and involved network of reach institutions, NGOs and local partners (TU, 2009). The measure is applied for the species in the EU (Hungary) (Csiszár & Korda, 2015).
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	The monitoring is needed indefinitely, and requires the development contingency plans and identification of funding sources for the detection survey work. A case study from Kansas (USA) evaluated the vegetation monitoring success of the closely related species *Asclepias meadii*. The result shows that small groups of observers were more successful in detecting the species than single observers, which highlights the manpower intensity of this measure (Alexander *et al.,* 2012).

Resources required [1] e.g. cost, staff, equipment etc.	Monitoring programmes are labour intensive and relatively costly as trained staff are needed to undertake the field work. Expert knowledge is required as well to develop actions plans and manage the data (TU, 2009).
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	No negative side effects are known.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	These recommended monitoring measures have a high acceptance amongst all stakeholder groups.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	There are no known socio-economic aspects to detail for this measure.
Level of confidence [2] See guidance section	**High.** The measure is documented in reports and various peer reviewed publications.

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	**Early detection at high risk sites using key stakeholder groups and at large scale using citizen science.** *Asclepias syriaca* establishes mainly in disturbed (ruderal) sites with moist soils, e.g. roadsides, railway embankments, ditches, fence lines or stream banks (Hartzler, 2010). According to an analysis of ecological indicator values and bibliographic data provided by Rutkowski *et al.* (2016), *A. syrica* can spread in a very wide range of habitats in open areas. For example, A. *syriaca* is currently occurring in various urban habitats (Matthews *et al.,* 2015), agricultural land, along river sites and grazing land (Rutkowski *et al.*, 2016). In urban areas the species benefits from the "heat island effect" of cities (Rutkowski *et al.*, 2016; Tokarska-Guzik and Pisarczyk, 2015). Across these urban, semi-urban and agricultural areas there will sites which are at high risk of invasion from *A. syriaca* (e.g. those in close proximity to existing infestations, or involve movement of top soils). At these sites visual detection of the species, by trained people from key stakeholder groups (e.g. horticulturalists, construction and transport industries, farmers) and also through citizen science, can be implemented as a measure for early detection. "*Citizen science surveys are potentially valuable tools for quickly obtaining information on biodiversity and species distributions"* (Maistrello et al., 2016).
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	The effectiveness of this measure for the species is unknown. The data collected by volunteers/citizen science would need to be checked by trained experts.
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	Early detection requires comprehensive surveillance of sites. By developing identification keys for stakeholder groups and the public could be used to identify the population development on large-scale. The current spread of *A. syriaca* shows similar pattern among member states (e.g. Hungary and Austria). The surveillance of large areas requires collaboration among authorities within a region (e.g. exchange of in information material on identification, starting training/information

	programs at the same time in all affected Member states). However, visual detection of *A. syriaca* using such measures would require significant amounts of planning, as the potential distribution of the species needs to be assessed and high risk sites need to be identified. Practically, it may also be difficult to find sites in the field, but GPS technologies are often in use (Csiszár and Korda, 2015). Seedling can be detected visually early in the season before the vegetation cover is fully developed (Hartzler and Buhler, 2000). However, it is in the flowering period of the species that the identification and detection is the easiest (June to July) (Bagi, 2008). This measure requires engagement of key stakeholders to monitor potential high risk sites.
Resources required [1] e.g. cost, staff, equipment etc.	Visual detection of *A. syriaca* needs trained staff. Expert knowledge is required to identify the high risk locations, and to train key stakeholder groups to detect the species in all phenological life stages. Expenses for training workshops need to be considered (up to 3,000 EUR). The resulting data would need to be collated and managed in a central database (however this system could be already established for other invasive species). If citizen science is being used, then training materials and smart phone apps could be developed to support their engagement.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	The measure is not destructive to native species. Further the training of staff can be supported by the engagement of local NGOs and experts.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	No information available. However, these measures could lead to increased costs for some sectors that rely upon the movement of soil, or are responsible for the management of high risk sites.
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 is considered to be low, regarding the multiple positive effects, e.g. raising public awareness. There are no socio-economic aspects to detail for this measure.

- the cost-effectiveness - the socio-economic aspects	
Level of confidence [2] See guidance section	**Moderate.** Detailed cost information is not available. The measure is commonly in use for various monitoring programs for invasive alien plants.

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	**Selective and localised spraying of plant protection products (PPP)** Cultivated fields in dry lands are also affected by the invasion of *A. syriaca* (Bhowmik, 1994; Botta-Dukát and Balogh, 2008). The measure includes the selective use of plant protection products (PPP) to kill individuals, aiming at the eradication of the species from infested sites. It is important to note that EU/national/local legislation on the use of plant protection products and biocides needs to be respected.
Effectiveness of measure e.g. has the measure previously worked, failed	The effectiveness of eradication using herbicides depends on the growth stage of *A. syriaca* (Szitár and Török, 2008). The suppression of A. *syriaca* seedlings by using chemical control measures can be successful in the short term (Szitár and Török, 2008). Herbicide application, in particular Glyphosate applications, are cost-effective chemical control measures that helps avoid soil surface disturbance and subsequent germination of milkweed seeds in the soil. However, it affects non-target plant species negatively (Szitár and Török, 2008).
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	After a single treatment *A. syriaca* can be successful eradicated (Szitár and Török, 2008). However, the sites needs to be monitored in the following seasons (Kiskunság National Park Directorate, 2011).
Resources required [1] e.g. cost, staff, equipment etc.	The application PPP requires chemical supply and equipment for distribution (Bhowmik, 2004). Staff need to be trained in detecting and identifying *A. syriaca* and differentiate from other plant species. The required resources for a rapid eradication of limited infested areas, include equipment, e.g. sprayer backpack (purchased from EUR 150), staff time, travel costs, safety equipment and monitoring over 2 or 3 seasons.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Especially in non-crop areas selective spraying is highly recommended, to mitigate the risk of negative impact on other species. In sensitive areas, e.g. protected areas, herbicides cannot be used (depending on the legislation on PPPs in the Member States). Since *A. syriaca* can be found near water, the use of PPPs might be not allowed (Balogh, 2001). There are no socio-economic aspects to detail for this measure.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The use of plant protection products can cause environmental problems and may affect human health. It's use has been criticized and is not recommended in many cases (Talbot *et al.*, 1991). The appropriate use and dosage needs to be always followed both in local and large scale control

	measures for the eradication *of A. syriaca* (Bhowmik, 2004).
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 measure was applied in the Kiskunság National Park (Hungary), as a part of a LIFE Project (LIFE06 NAT/H/000104, 2014) . In the final report of the LIFE Project LIFE06 NAT/H/000104 the measure was considered to be very expensive and time-consuming.
Level of confidence [2] See guidance section	**High.** The measure, whenever correctly applied, can rapidly eradicate *Asclepia syriaca* as demonstrated in the EU (Hungary).

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	**Manual and mechanical control to fully remove the vegetative and generative plant parts** This measure includes the physical removal of individuals including their root system by hand pulling aided by using machinery, e.g. rotators. The biggest problem with controlling *A. syriaca* is the perennial rootstock bearing adventitious buds which are capable of sprouting in a favourable environment. The perennating activity is renewed annually from these adventitious buds, therefore the rootstock must be completely removed or it will sprout and send up new plants. The best way to do this is to start digging about a 30-40 cm from the base of the plant, digging all the way around and as deeply as possible (Bhowmik, 2004; Land Steiermark, 2017; Morse and Schmitt, 1985). Further mechanical control measures including the removal of stalks by clipping or mowing, induces lateral root buds to sprout and is therefore not effective for rapid eradication (Bhowmik, 2004). In addition, prescribed fires should be avoided as fire can favour *A. syriaca* (Bagi, 2008; Botta-Dukát & Balogh, 2008).
Effectiveness of measure	When *A. syriaca* occurs in semi-natural habitats, individuals need to be treated one by one (e.g. by

e.g. has the measure previously worked, failed	hand pulling), without affecting native and endangered plants (Csiszár & Korda, 2015). Since *A. syriaca* also spreads by vegetative means, the measure is only effective if the entire root system and all of the stem parts are removed (Morse and Schmitt, 1985). The removal of roots is an effective measure for the removal of individuals (Land Steiermark, 2017; Stevens, 2003; Szitár and Török, 2008). The use of machineries can limit the effectiveness, because the root system might be chopped in small fragment, which could then spread to an even larger area (Bhowmik, 1994).
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	Controlled locations need to be regularly monitored. Undertaking a single treatment does not guarantee the successful eradication (Bagi, 2008; Land Steiermark, 2017).
Resources required [1] e.g. cost, staff, equipment etc.	There is no specific information on the cost of this measure. Larger stands can be only removed cost efficiently using a rotator (Land Steiermark, 2017; OEBU, 207AD). The measure requires experts, who detect the species (Balogh, 2001; Csiszár and Korda, 2015; TU, 2009). The cost of early removal of single individuals in an early stage of vegetative development is expected to be relatively low, as adult individuals develop a strong root system, that is more difficult to remove (Bagi, 2008). Therefore, the removal of developed individuals is time consuming, requires digging equipment and manpower. Any removal treatment requires monitoring in the following vegetation period. There is also a need to wear gloves when hand pulling.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Root removal consequently creates a disturbance to the surrounding vegetation cover. The reinvasion by *A. syriaca* or other IAS is possible. Sites where a treatment was performed need to be monitored in the following years. The reintroduction of native plant species may be useful to hinder recolonization by *A. syriaca* (D'Antonio and Meyerson, 2002).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Hand pulling (including manual digging the root stock) of single individuals is the less impacting method to eradicate *A. syriaca*. The use on machineries may affect the growth of native plant species, which grow in little distance to the targeted individual. Especially in protected areas mechanical control needs to be combined with further measures to support the reestablishment of native plant species.
Additional cost information [1] When not already included above, or in the species Risk	The digging and rootstock removal is time consuming and labour intensive. The costs of manual control measures are high, and only effective under certain circumstances, e.g. eradication of few

Assessment. - implementation cost for Member States - the cost of inaction - the cost-effectiveness - the socio-economic aspects	individuals. There are no socio-economic aspects to detail for this measure.
Level of confidence [2] See guidance section	**Moderate** The effectiveness and costs of this measure have not been evaluated for the species *A. syriaca*. But mechanical removal is commonly in use (Bhowmik, 1994, 2004; Botta-Dukát and Balogh, 2008).

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	**Limiting seed dispersal by mowing/cutting** This measure involves the mechanical removal of the plants before flowering in order to limit the seed production and dispersal for agricultural areas and grasslands (note there is a separate Management table below that deals specifically with roadside verges). By producing wind-dispersed, plumed seeds, *A. syriaca* is capable of spreading from an existing population to colonize a newly disturbed site (Morse and Schmitt, 1985). The production of seeds can be limited, by cutting/mowing the inflorescences before flowering (Stevens, 2003). The removed plants need to then be destroyed after removal.
Effectiveness of measure e.g. has the measure previously worked, failed	The aim of this measure is to limit the further spread of an established population, rather than the eradication of it. However, *A. syriaca* does not form a persistent soil seed bank (Csontos *et al.,* 2009). The annual repetition of limiting the generative reproduction can be effective in the long-term. The measure is more effective, if it is combined with selective control measures such as chemical control or early detection measures (LIFE06 NAT/H/000104, 2014).
Effort required e.g. period of time over which measure need to be applied to have results	The cutting of the plants needs to take place twice a year removing the above ground parts of the plant to prevent the development of seeds *(Kelemen et al.*, 2016).
Resources required [1] e.g. cost, staff, equipment etc.	It requires the use of suitable mowing machinery and trained operators. Structures for containing/impounding the material for long-term disposal would also need to be put in place. The

	costs of physical control measures have not been quantified.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	There is the risk that the fragments of the plants are unintentionally spread to uninvaded areas by mishandling the removed plant material. *A. syriaca* is capable of vegetative reproduction (Morgan and Schoen, 1997). Therefore, all removed plant parts need to be destroyed after removal.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The species mainly occurs in disturbed areas, where no economic activities are impacted (Csontos *et al*., 2009).
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 are no socio-economic aspects to detail for this measure.
Level of confidence [2] See guidance section	**Low** Data on long term effectiveness and costs are not 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	**Cultural control of farming practices (management of crop fields)** As *A. syriaca* invades agricultural land, cultural control measures including crop rotation and planting of competitive crops are summarized in this section (Hartzler and Buhler, 2000). In general, crop rotations involving forage grasses or legumes, small grains, and irrigated corn help to control *A. syriaca* (Bhowmik, 1994). In conventional agricultural cultivation systems soybean-winter wheat rotation suppresses the establishment of seedling of *A. syriaca* best (Yenish, Wyse, Durgan, and Fry, 1997). Plantation of competitive crops can limit common milkweed seedling establishment in the early stage of invasion (Bhowmik, 1994). Further the dense plantation of winter wheat into a field that is invaded by *A. syriaca* can aid the control by outcompeting it (Bhowmik, 1994).

Effectiveness of measure e.g. has the measure previously worked, failed	The effectiveness is limited, when the stand of *A. syriaca* are established (Bhowmik, 1994, 2004; Hartzler, 2010). Further the rootstocks remain in the soil and might be even spread by agricultural machineries.
Effort required e.g. period of time over which measure need to be applied to have results	Cultural control is the adoption of crop rotation practices to outcompete *A. syriaca*. For this to be successful it may take several years (Kephart, 1987). Knowledge needs to be shared with large groups of users, e.g. farmers (Bhowmik, 2004).
Resources required [1] e.g. cost, staff, equipment etc.	No additional equipment is required to what is usually available to agricultural farms. A rotation plan and long term management plan need to be developed (Bhowmik, 2004; Hartzler and Buhler, 2000).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Adaption of the agricultural practice (changes of the rotation plan) is necessary (Bhowmik, 2004). The measure is an herbicide free option for organic farming (Bhowmik, 2004). Crop rotation can have agronomic and environmental benefits compared to monoculture cropping.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The change of crop production practice could affect the economic efficiency and profit of agricultural production in short terms (Olesen *et al.*, 2011; Tilman, Cassman, Matson, Naylor, and Polasky, 2002).
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 information on cost is available.
Level of confidence [2] See guidance section	**High** The measure was developed, analysed and applied over a period of 20 years, mainly in the USA (Bhowmik, 2004; Hartzler, 2010).

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	**Roadside/verges management** Road security regulations generally require the vegetation of road verges to be kept at a low height for safety (Milakovic, Fiedler, and Karrer, 2014) or for reducing fire risk. Roadside verges are common corridors for the spread of A*. syriaca* (Hartzler and Buhler, 2000) and many other invasive alien plants. For example, in Central Slovakia established populations of *A. syriaca* are recorded (Pauková *et al.,* 2013). adapting existing mowing regimes/timing of the cutting of the road side vegetation (usually conducted by road maintenance authorities) could be beneficial in the management of A. syriaca, as this has approach has been used for *Ambrosia artemisiifolia* (ragweed) in Austria (Milakovic, Fiedler, & Karrer, 2014).
Effectiveness of measure e.g. has the measure previously worked, failed	The adaptation of roadside management to the species phenological cycle can be an effective measure to manage large populations of this invasive plant species *(Milakovic et al.,* 2014). Mechanical mowing of roadside verges is a measure in use to control the spread of *Ambrosia artemisiifolia* (common ragweed), leading to a reduction of seed production. The unintentional spread of the species by mowing can be limited, if the roadside management adapts the mowing timing to the species phenological cycle. Specific data on the phenological cycle of populations of *A. syriaca* along road sides are not available.
Effort required e.g. period o f time over which measure need to be applied to have results	The measure requires the machinery, vehicles and equipment, in order undertake the mowing, and removal and destruction of the cut plants, but also the regular cleaning of machinery and vehicles to avoid the unintentional spread of seeds or other plant specimens (see table above on prevention of unintentional spread). for further information see Milakovic et al. *et al.* (2014a, b). The management action requires regular monitoring of regrowth and repetition.
Resources required [1] e.g. cost, staff, equipment etc.	The resources include the seasonal acquiring additional mowers, because a large area needs to be controlled in the same time period, which is adapted to the species phenology. Training needs to be provided for the staff (Joly *et al.*, 2011).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	The awareness of the road as a potential corridor for invasive plant species spread increases due to this interdisciplinary approach.
Acceptability to stakeholders	The measure is integrated in many technical guidance documents and management plans (Brett,

e.g. impacted economic activities, animal welfare considerations, public perception, etc.	2015; SEWISC, 2016) . The acceptance of the measure is high although the realisations remains difficult, due to complicated logistics and resources (Milakovic, Fiedler, and Karrer, 2014).
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 information on the cost effectiveness available. The measure is not implemented for the species *A. syriaca*. It is commonly in use for *Ambrosia artemisiifolia* (common ragweed). There are no socio-economic aspects to detail for this measure.
Level of confidence [2] See guidance section	**Moderate** Although the measure was not specifically applied for *A. syriaca*, if shows significant impact on the pathway control and therefore needs to be considered.

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	**Chemical control** The management of *A. syriaca* using herbicides is a common practice in agricultural areas in the USA (Hartzler, 2010). In agricultural sites *A. syriaca* seedlings "*are controlled by the same soil-applied herbicides that control broadleaf weeds in corn, sorghum, and soybeans. Soil-applied herbicides include atrazine[6-chloro-N-ethyl-N'-(methyJethyl)-1,3,5-triazine-2,4-diamine], EPTC (Sethyl dipropylcarbamothioate), and metribuzin [4-amino-6-(1, 1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4H)-one], or combinations thereof*" (Bhowmik, 1994). "*Aboveground plant parts may be destroyed by herbicides including 2, 4-D, mecoprop, dicamba and MCPA, but growth of adventitious roots is stimulated by this action. Amitrole-T and glyphosate will kill top growth and result in restricted regrowth during the following season*" (CABI, 2017). The herbicide glyphosate (Medallon, 2 l ha-1) was applied to eradicate *A. syriaca* by machine broadcast to an invaded site (Szitár and Török, 2008). It is important to note that EU/national/local legislation on the use of plant protection products

	and biocides needs to be respected.
Effectiveness of measure e.g. has the measure previously worked, failed	Chemical control can be effectively used for high density large populations in agricultural areas. In agricultural crops herbicides are an effective measure when the plantation of competitive crops did not limit *A. syria*ca seedling establishment (Hartzler, 2010). Glyphosate seems to be most effective overall and may reduce *A. syriaca* occurrence in crop fields (CABI, 2017) and according to Szitár and Török (2008) *Glyphosate application is a cost-effective control method that helps avoid soil surface disturbance and subsequent germination of milkweed seeds in the soil*". Further the application timing of herbicides in relation to plant growth plays an important role in herbicide effectiveness (Bhowmik, 1994).
Effort required e.g. period of time over which measure need to be applied to have results	The sites need to be monitored in the following years to evaluate the success of the treatment. Occasionally, the treatment needs to be repeated in the following years.
Resources required [1] e.g. cost, staff, equipment etc.	No specific training for the staff regarding identification of *A. syriaca* is needed. The measure can be used to control large areas, therefore a large amount of herbicide is used.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Glyphosphate applications may have negative environmental effects and affect non-target species (Szitár and Török, 2008) or may be forbidden in some cases (e.g. inside protected areas). Further the measure leads to changes in plant species composition. The Glyphosate treatment is not selective and therefore will remove all vegetation including non-target species leading to an earlier stage of succession, which is very sensitive to re-invasions (Mason and French, 2007; Szitár and Török, 2008). The use of herbicides near watercourses is restricted or forbidden in some cases.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Environmental and economic considerations need to be made. The occurrence and potential impact on the surrounding species and habitats needs to be assessed.
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	There are no additional socio-economic aspects to detail for this measure.

- the socio-economic aspects	
Level of confidence [2] See guidance section	**High.** The measure is applied to rapidly eradicate *Asclepias syriaca* in the USA and in the EU.

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	**Rabbit grazing** *A. syriaca* is poisonous and contain cardiac glysosides, which are toxic and may cause death in mammalian herbivores and some generalist insect herbivores *(Ducs et al.*, 2016). While *A. syriaca* has a poisonous milky sap, its toxic properties are destroyed by boiling and even used for pharmaceutical purposes. Although the species is toxic for the majority of mammalian herbivores, it was found that European rabbits (*Oryctolagus cuniculus*) are capable of digesting *A. syrica* (Ducs *et al.*, 2016). Due to the potential to adapt food preferences of the species, European rabbits grazing could potentially be considered for the control of *Asclepias syriaca* (Ducs *et al.,* 2016), in areas where the European rabbits are already established.
Effectiveness of measure e.g. has the measure previously worked, failed	The measure needs further scientific development and experiment based data. Rabbit grazing is used as an effective biological control to stop spread of the milkweed in the Kiskunság National Park, Hungary (Ducs et al., 2016).
Effort required e.g. period of time over which measure need to be applied to have results	Dietary preference need to be "transmitted from mother to young already in the nest, prior to weaning", (Ducs *et al.*, 2016). Technical protocols for the application of this measure do not exist yet.
Resources required [1] e.g. cost, staff, equipment etc.	The scientific development of the measure requires capital investment. Further the field work needs to be provided by trained staff, and monitored by experts and veterinarians.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	The introduction of the European rabbit for the control of *A. syriaca* needs to be avoided. No negative side effects are to expected in areas where the European rabbits are established.

Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	No symptoms of poisoning in the conditioned rabbits were found. The development of the measure requires live animal testing, which may cause negative public perception.
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 detailed information on cost is available. However, the results of the case study provided by Ducs *et al.* (2016) showed that grazing by the European rabbit is a cost effective measure. The measure can also be tested for other mammalian herbivores, e.g. goats.
Level of confidence [2] See guidance section	**Moderate.** The measure was tested in the Kiskunság National Park, Hungary.

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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)