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)	*Elodea nuttallii* (Planch.) H. St. John
Species (common name)	Nuttall's waterweed
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Summary

Highlight the measures that provide the most cost-effective options to prevent the introduction, achieve early detection, rapidly eradicate and manage the species. Also note where there are significant gaps in information or knowledge to identify cost-effective measures.
Elodea nuttallii is a perennial submerged aquatic plant species. Native to North America, the species has spread into 19 European countries (Hussner, 2012). While *Elodea nuttallii* is already widespread in some countries (e.g. Germany and The Netherlands), the species is less common in Eastern Europe. The species is able to establish in all parts of Europe and has shown its invasive potential already in numerous waters in Europe (Podraza *et al.*, 2008; Zehnsdorf *et al.*, 2015). *Elodea nuttalllii* spreads easily via plant fragments and even small fragments are able to regenerate (Kuntz *et al.*, 2014). The control and eradication of this species is very difficult (Zehnsdorf *et al.*, 2015; Podraza, 2017), and thus it is important to act as soon as possible, when a new infestation is found. Early detection and rapid eradication is crucial for the successful management of the species. Early detection is best achieved if the public is informed about the species and if there is a well-coordinated program with public awareness campaigns to identify new infestations. Early eradication of small infestations is possible with hand weeding, benthic barriers, suction dredging, or by a combination of control measures. Eradication of large infestations is difficult to achieve (Hussner *et al.*, 2017). *Elodea nuttallii* was imported and traded within shops in Europe, but the number of plants imported and traded was rather low (Brunel, 2009; Hussner *et al.*, 2014).

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. In general, the ornamental trade was identified as the major pathway for the introduction of invasive alien aquatic plants (IAAPs) into a new country (Kay and Hoyle, 2001; Maki and Galatowitch, 2004; Cohen *et al.*, 2007; Martin and Coetzee, 2011). In New Zealand, 27 out of 30 aquatic plant species managed under legislation were imported through trade (Champion *et al.*, 2010). Consequently, the prevention of further introductions of a species via the trade is considered to be the cheapest and easiest way to close this pathway and to subsequently reduce the future negative impact and management costs of IAAPs. The numbers of *Elodea nuttallii* plants introduced into Europe, and the presence of the species in shops, was relatively low compared to other aquatic plants (Brunel, 2009; Hussner *et al.*, 2014). However, every single *Elodea nuttallii* plant introduced and sold must be considered as a risk for secondary release into aquatic habitats.

Effectiveness of measure e.g. has the measure previously worked, failed	Trading of *Elodea nuttallii* was prohibited in jurisdictions where plants were first classified using an Aquatic Weed Risk Assessment Model (AWRAM) (e.g. in New Zealand), whereby plant species with a score of > 50 out of 100 were either managed by being banned from sale or by statutory control (Champion *et al.* 2010). However, *Elodea nuttallii* is already widespread within Europe (Hussner 2012) and the effectiveness of bans for this species would be rather limited. The species is spreading between water bodies via fragments, and the proportion of new infestations caused by the release of plants from horticulture is considered to be very low. The success of bans is difficult to quantify, but depends on various parameters, e.g. on the species identification knowledge of the responsible authorities controlling the import of plants, and correct labelling of plant material (Hussner *et al.* 2014). Overall, the identification of *Elodea nuttallii* is difficult due to the high phenotypic plasticity of the species (Thiebaut and Di Nino 2009) and its close relatives (*Elodea canadensis* and *Elodea ernstiae*). Hybrids between *Elodea nuttallii* and *Elodea canadensis* may occur (Cook and Urmi-König, 1985).
Effort required e.g. period of time over which measure need to be applied to have results	Bans must be applied for the long-term to support any significant and sustainable success in controlling the spread of this species. However, the success or failure of control measures depends on parameters like species knowledge of responsible authorities (particularly at the border control), the labelling of plants and the current distribution of the species (the more widespread the species, the smaller the effects of trading bans). Special consideration must be given to the contamination of other plant material in trade (Champion *et al.*, 2010). Additionally, illegitimate names, spelling mistakes and mislabelling make it difficult to identify the target species (Brunel, 2009; Hussner *et al.*, 2014).
Resources required [1] e.g. cost, staff, equipment etc.	The implementation of trading bans require a good species knowledge and identification skills on the part of the responsible authorities. For other IAAPs, DNA barcoding tools were developed to simplify species identification (e.g. for *Hydrocotyle ranunculoides*; van de Wiel, 2009), but this has not been developed for *Elodea* spec. yet. There is no information available about the costs and the equipment required to implement trading bans, but it is a widely accepted fact that prevention is a cheaper than management of a given species (Hussner *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.	The implementation of a trading ban would generally increase the control measures in place to hinder the introduction of IAAPs. Thus it seems high likely, that the control measures will lead to the identification of other invasive alien aquatic plant species in trade, especially of relatives of *Elodea nuttallii* like *Egeria densa* or *Lagarosiphon major*.
Acceptability to stakeholders	The direct impact on the economy must be considered as low, as *Elodea nuttallii* was only traded in

e.g. impacted economic activities, animal welfare considerations, public perception, etc.	low numbers (Brunel, 2009; Hussner *et al.*, 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 data on the costs of the implementation and action of trading bans are available, but due to the low number of *Elodea nuttallii* plants found in trade (Brunel, 2009; Hussner *et al.*, 2014), the economic loss to traders can be considered as low. Apart from the costs caused by the trading ban, it is a widely accepted fact, that trading bans provides a high level of efficiency in preventing IAS introductions at a relatively low cost in comparison to the management of IAAPs infestations (Hussner *et al.* 2017). In the case of *Elodea nuttallii*, the cost of inaction is difficult to determine. The species can grow in most parts of Europe, but the spread between and within water bodies is largely via fragments produced from existing populations.
Level of confidence [2] See guidance section	**Moderate** *Elodea nuttallii* has just been banned from sale, but for other species trading bans were successfully implemented. In the case of *Elodea nuttallii*, its wide distribution within the EU will limit the effects of trading bans, as the species is spreading from existing populations.

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	**Measures to stop the unintentional human-mediated dispersal of *Elodea nuttallii* via fragments.** The spread of IAAPs into new water bodies is largely based on the human-mediated dispersal of plant fragments via watersport equipment (Johnstone *et al.*, 1985; Johnson *et al.* 2001). Aquatic plant fragments are produced either by allofragmentation (caused by disturbances) or autofragmentation (self-induced). The number of fragments produced differs between species (Heidbüchel *et al.*, 2016). Significantly higher fragmentation rates were found for *Elodea canadensis* than for other invasive submerged aquatic plants (Redekop *et al.*, 2016). Even though the fragmentation rates of *Elodea nuttallii* have not yet been studied in detail, similar high fragmentation rates are expected. The higher the number of produced and dispersed fragments, the more likely a species is to spread successfully (Lockwood *et al.*, 2005). While water movement facilitates spread within aquatic

	systems (Riis and Sand-Jensen, 2006), the overland dispersal of fragments largely depends on human assistance (Johnstone *et al.*, 1985). To stop the further spread of an IAAP like *Elodea nuttallii*, this human-mediated spread must be controlled. This can be achieved by informing the public and by preventing the dispersal of viable fragments. Public campaigns (like the "Stop Aquatic Hitchhikers" campaign in the US, https://www.fws.gov/fisheries/ans/pdf_files/Stop_Aquatic_Hitchhikers_factsheet.pdf) inform the public and increase the public awareness. The transport of viable fragments can be reduced by (i) reducing the likelihood of fragments attached to the boat by creating weed free haul-out areas; (ii) collecting all visible plant fragments from watersport equipment (particularly boats and trailers), (iii) drying the plant fragments attached to the boat by storing the boat on dry land for a certain amount of time, and (iv) placing the boat into a heated water system that kills fragments (Johnstone *et al.*, 1985; Barnes *et al.*, 2013; Anderson *et al.*, 2015).
Effectiveness of measure e.g. has the measure previously worked, failed	Public campaigns (e.g. "Stop Aquatic Hitchhikers" and "Clean, Drain, Dry") were initiated in e.g. the US, Canada or New Zealand (http://www.env.gov.bc.ca/fw/fish/regulations/docs/1011/fa_AquaticHitchhikers.pdf; https://www.fws.gov/fisheries/ans/pdf_files/Stop_Aquatic_Hitchhikers_factsheet.pdf; authors observations). However, the efficiency of measures taken against human-mediated overland dispersal is difficult to quantify. Considering the strong evidence for the importance of human-mediated spread of plant fragments via watersports equipment (Johnstone *et al.* 1985), measures to stop this vector of unintended spread should be considered to have a potentially high impact. However, success or failure depends on various parameters, e.g. the resistance of fragments to desiccation and heating (Barnes *et al.*, 2013; Anderson *et al.*, 2015), and the minimum size of fragments needed for regeneration (Kuntz *et al.*, 2014).
Effort required e.g. period of time over which measure need to be applied to have results	Measures to stop the human mediated dispersal of IAAPs must be applied for the long-term to guarantee significant sustainable success. These measures require a comprehensive public campaign and the installation of infrastructure such as hot water ponds to kill plant fragments (Anderson *et al.*, 2015). In New Zealand, nets were installed to create weed free haul-out areas in lakes infested with weeds, reducing the likelihood of weed fragments becoming attached to boats and trailers (authors observations).
Resources required [1] e.g. cost, staff, equipment etc.	The costs of generating a public campaign are relatively low compared to the costs of managing established IAAPs, but data about the total costs of these campaigns are not available. The

	installation of net cages in lakes to create weed free areas requires scuba diving activity.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	The described measures provide a barrier to the dispersal of unwanted organisms in general, and not purely a single species. This could also have a negative impact on the dispersal of native organisms. But such negative impacts on native plants were not reported yet.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The suggested measures have an impact on recreational water sport activities, but this impact is low compared to the high impact of the nuisance growth of *Elodea nuttallii*, such as has been experienced in reservoirs of the River Ruhr (Podraza *et al.,* 2008). Consequently, the measures might have a high public perception, even though this has not been analysed yet. The measures to kill plants fragments attached to the boat and trailer (heating; clean, drain, dry) also impact on animals attached to the boat (e.g. *Dreissena* species, zebra and quagga mussel), and thus also help to control the spread of alien fauna (Johnson *et al.*, 2001).
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 data on the costs of the public campaigns and in field measures are available. In comparison to management costs, the costs of mounting a public campaign must be considered to be low, resulting in a good level of cost-effectiveness. Consequently, the cost of inaction is much greater than the cost of implementing prevention methods (Hussner *et al.*, 2017). However, due to the wide distribution of *Elodea nuttallii* in large parts of Europe, the cost of implementing these prevention methods at such a large scale (such as the installation of net cages), should be considered to be high if a sustainable and significant impact on *Elodea nuttallii* distribution is to be achieved. As mentioned above, the costs of inaction are difficult to determine, as *Elodea nuttallii* is able to grow in a wide range of freshwater ecosystems and spreads easily.
Level of confidence [2] See guidance section	**High** Public campaigns to hinder the human mediated spread of invasive aquatic plants were implemented in e.g. New Zealand or the US with good success. They should be implemented in the EU as a valuable tool to stop the spread of species. For *Elodea nuttallii* the prevention of human mediated spread is important, as the species is spreading with plant fragments from the already existing populations within Europe.

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 through surveying, including citizen science.** The early detection of invasive alien aquatic plant species is a key factor in the successful rapid eradication of new infestations. Thus programmes centred on early detection and rapid eradication are crucial for effective management and successful eradication (Genovesi *et al.*, 2010; Hussner *et al.*, 2017). Early detection and rapid eradication is a proactive approach, focussed on the successful management of alien species prior to their establishment. After the early detection of an IAAP like *Elodea nuttallii*, well-coordinated rapid management measurements are required, which must take into account the IAAP's specific biology and habitat characteristics to achieve the total eradication of the target species (Hussner *et al.*, 2016; Hussner *et al.*, 2017). The high phenotypic plasticity of *Elodea nuttallii* and the occurrence of hybrids with *Elodea canadensis* make identification difficult (Thiebaut and Di Nino, 2009; Cook and Urmi-König, 1985), and limit the applicability of early detection methods. However, determination keys and apps have been developed and provided to the public, enabling people to identify and report geolocated sites of infestations of IAAPs. This information can be used to facilitate rapid response, and can furthermore be used for the mapping of IAAPs in larger invaded areas (Hussner *et al.*, 2017). For early detection, comprehensive monitoring activities are required, and for submerged aquatic plants like *Elodea nuttallii* the identification of an early-stage infestation is only achievable (particularly in lakes > 5m in depth) when scuba diving is used as a tool. Involving the public and providing them with identification tools is necessary (Hussner *et al.*, 2017), especially when considering the large number of recreational scuba divers. In Germany, scuba divers and the Federal Agency for Nature Conservation initiated a joint project, informing the recreational scuba divers about IAAPs and providing brochures and identification keys (http://www.neobiota.info/Neophyten.php).
Effectiveness of the surveillance e.g. has the surveillance previously worked, failed	Early detection and rapid eradication have been documented as successful methods in the eradication of new infestations of invasive species (Anderson, 2005). However, the identification of early infestations of submerged aquatic plants like *Elodea nuttallii* is difficult to achieve for various reasons. As *Elodea nuttallii* is a submerged aquatic plant species, numerous new infestations were identified e.g. during macrophyte mapping by scuba divers when studying the ecological status of water bodies according to the Water Framework Directive (WFD) (Hoffmann *et al.*, 2013). Moreover, due to the difficulties in finding small plants and / or small infestation, particularly in turbid aquatic habitats, even a zero-detection survey result does not necessarily mean that the species is absent (Anderson, 2005). The value of surveys by scuba divers depends on (i) the diver's

	efficiency in identifying the target species is based on species knowledge and experience; (ii) the minimum size of the IAAPs infestation must be large enough to enable its detection by scuba divers; and (iii) the period of time the IAAPs need to reach the critical population size to enable detection (Anderson 2005). For submerged IAAPs there are hardly any reports on early detection and rapid eradication actions, illustrating a large research gap which must be closed to improve the quality and success of EDRR measurements.
Effort required e.g. required intensity of surveillance (in time and space) to be sufficiently rapid to allow rapid eradication	In the past, early detection of submerged *Elodea nuttallii* required comprehensive surveillance of the macrophyte communities in lakes. In rivers, scuba diving is not necessarily required, due to the lower depth limit of submerged plants as a result of the high turbidity. Nevertheless, the surveillance of aquatic habitats is much more time-consuming and costly than in terrestrial habitats. But new techniques such as hyperspectral remote sensing (Hestir *et al.*, 2008), can be used for the large-scale surveillance of water bodies, but are probably less sensitive than small-scale surveillance undertaken by scuba divers. A new powerful tool to find even small infestations is the use of eDNA markers, which allow the identification of even small infestations of IAAPs (Scriver *et al.*, 2015; Matsuhashi *et al.*, 2016).
Resources required [1] e.g. cost, staff, equipment etc.	Early detection seems only achievable by comprehensive and repeated monitoring. By developing identification keys for the public and developing apps for mobiles, the cost of monitoring can be reduced and larger areas can be surveyed. Nevertheless, professional scuba diving seems indispensable, when rapid eradication is required. Small infestations of submerged *Elodea nuttallii* must be completely eradicated, and the production of fragments during the control programme limited if eradication is to be achieved. The use of new techniques like eDNA can help to reduce the costs for presence / absence surveillances. However, no information on the cost of early detection and rapid eradication of aquatic plants is available.
Side effects (incl. potential) i.e. positive or negative side effects of the method on public health, environment, non-targeted species, etc.	During monitoring, other IAAPs can be identified, which reduces the total cost of IAAPs monitoring. This is true for both observational monitoring such as by scuba diving, and also for remote analysis such as eDNA studies. The negative effects of early detection and rapid eradication on the habitats which must be managed in the restoration period are much lower than the effects of other management methods (Hussner *et al.*, 2017). Small infestations which are identified at an early stage of encroachment are easier to eradicate and thus intervention at this stage will have less negative impact on the ecosystem than control measures taken on an established infestation.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Early detection and rapid eradication will have less impact on ecosystems and economic and recreational activities than other management efforts, which are carried out to control large IAAPs infestations (Hussner *et al.*, 2017). Informing the public and providing apps for non-scientists will increase the acceptance of EDRR methods compared to comprehensive control measures.
Additional cost information [1]	There is no information available on the overall costs of early detection and rapid eradication

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	actions on IAAPs like *Elodea nuttallii*. However, the costs of inaction will be much higher, as the control and eradication of large infestations of IAAPs is much more time-consuming and costly (Hussner *et al.*, 2017). The cost-effectiveness of early detection and rapid eradication actions on aquatic plants has not been studied in detail yet and will differ between species, infested habitats and the management methods required for the eradication of the species.
Level of confidence [2] See guidance section	**Moderate** Early detection and rapid eradication is considered as a high cost efficient control method. *Elodea nuttallii* is already widespread within the EU, but early detection will help to stop the future spread of the species.

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 harvesting (hand-weeding)** The manual harvesting of IAAPs is one of the most species-specific control methods available (Hussner *et al.*, 2017). It is used for the control of early and small infestations of IAAPs, when the eradication of the target species is achievable, and for the selective removal of a target species within mixed plant communities (de Winton *et al.* 2013; Hussner *et al.*, 2016). Hand-weeding is also used, when other mechanical control methods are not an option, e.g. in shallow water (Bailey and Calhoun, 2008; Hussner *et al.*, 2017). Furthermore, hand-weeding can be used in integrated control programmes, e.g. as a follow-up to larger control measures, to eradicate remaining patches of the target species (Gettys *et al.*, 2014; Hussner *et al.*, 2017). Hand-weeding is carried out by wading in shallow water or by snorkelling and diving in water depths > 1.2m (de Winton *et al.*, 2013). The success of hand-weeding depends on the plant species and the skills and techniques of the operator (de Winton *et al.*, 2013). During hand-pulling, the operator should dislodge the root system of the plants from the sediment, as otherwise the plant will regrow from the remaining root system (Gettys *et al.*, 2014). This method is used best for species with high shoot strength (e.g. *Ludwigia grandiflora*), while species with brittle shoots (e.g. *Elodea nuttallii*) are more difficult to harvest and any shoot breakage with the production of plant fragments should be avoided.
Effectiveness of measure	Hand-weeding is highly effective, when carried out by skilled operators using appropriate

e.g. has the measure previously worked, failed	equipment. Manual harvesting by scuba divers has been used for the successful eradication of isolated patches of *Lagarosiphon major* in New Zealand lakes (de Winton *et al.*, 2013). In the North-East of France, hand weeding was tested in field trials for the control of *Elodea nuttallii*, and a > 90 % reduction of biomass was achieved after two harvests (one in early spring during plant regrowth and another one three months later) (Di Nino *et al.*, 2005). Hand-weeding was reported as effective for the control of Elodea spec. in Alaska (Etcheverry, 2012).
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	The majority of plants can be removed with the first hand-weeding operation. Plant regrowth will most likely occur and thus the weed eradication will require follow-up management measures, until the last plant shoot / fragment has been successfully removed (de Winton *et al.*, 2013; Hussner *et al.*, 2016). De Winton *et al.* (2013) recommended monitoring for 3-5 years after the removal of the last fragments before the eradication of the species can be confirmed.
Resources required [1] e.g. cost, staff, equipment etc.	For the hand-weeding, waders and snorkel or diving equipment is required. For the safety of the operators in and on aquatic systems, personal floatation devices, skills in boat handling, diving and diver operated hand-weeding are mandatory (de Winton *et al.*, 2013). De Winton *et al.* (2013) estimated the costs of hand-weeding for two hand weeding treatments to achieve weed eradication of about NZD 20,000 per ha (about 12,000 EUR). The costs for follow-up treatments can be reduced by using volunteers who are able to identify plant regrowth and eliminate these plants.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Hand-weeding is a species-specific control measure with minimal negative effects on native plants, if the management is carried out by skilled operators. During the hand-weeding and uprooting of plants the water can become turbid, but this will have no sustainable effect on the environment.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	As hand-weeding has only a minor negative impact on an ecosystem, a high acceptance of hand-weeding measures from stakeholders and the public are highly likely. No impacts of hand-weeding on animal welfare have been reported.
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	Hand-weeding causes relatively high costs per area, but the cost-effectiveness is high when eradication of *Elodea nuttallii* is achieved. As hand-weeding is only considered to be a viable eradication method for small infestations, inaction will lead to the spread of the target species, increasing the management costs and reducing the likelihood of future eradication.
Level of confidence [2] See guidance section	**High** Hand weeding has been used for the successful control and eradication of small infestations of IAAPs, including *Elodea nuttallii*.

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	**Shading with benthic barriers** Benthic barriers prevent light penetration to the sediment and do not allow plants to root in the sediment (de Winton *et al.*, 2013; Gettys et al,. 2014). Bottom shading with benthic barriers is used for the control of submerged IAAPs (Boylen *et al.*, 1996; Caffrey *et al.*, 2010; Laitala *et al.*, 2012; Hoffmann *et al.*, 2013). Shading with benthic barriers is a non species-specific management practice, which can be used in stagnant waters (de Winton *et al.*, 2013). It is used for small infestations of IAAPs (<0.4 ha; de Winton *et al.*, 2013) and can provide both one-off weed eradication and medium- to long-term control over years in waters with larger weed beds, where eradication is not achievable (de Winton *et al.*, 2013; Gettys *et al.*, 2104; Hussner *et al.*, 2017). For long-term control, long-lasting polypropylene mats can be used (de Winton *et al.*, 2013). It must be considered that any form of bottom shading can be thwarted by high suspended sediment loading in the water column, as accumulation of sediment on top of the benthic barriers can provide a suitable substrate for new infestations of plants on the barriers (de Winton *et al.*, 2013, Hoffmann *et al.*, 2013). As an alternative to long-lasting plastic or polyethylene sheeting, biodegradable jute, hessian or coconut matting can be used. While plastic or polyethylene do not allow gas exchange and thus may reduce dissolved oxygen beneath the sheeting, jute mats allow the exchange of water and gas and even some native plants are able to grow through the mats (Caffrey *et al.*, 2010; Hoffmann *et al.*, 2013). Biodegradable mattings should be used when the eradication of an IAAP is sought in small ponds or lakes and only temporary installations of benthic barriers are required (de Winton *et al.*, 2013). Furthermore, the natural degradation of the jute mat following suppression of the target IAAP allows natural regrowth of native plant communities (Caffrey *et al.*, 2010) and thus provides a management tool without creating fresh disturbance after the successful eradication of the IAAP.
Effectiveness of measure e.g. has the measure previously worked, failed	Benthic barriers (usually plastic sheeting) successfully controlled *Myriophyllum spicatum* and an eight weeks placement of geotextiles successfully removed the species (Laitala *et al.,* 2012). Biodegradable jute matting was successfully used to control *Lagarosiphon major* (Caffrey *et al.*,

	2010) and *Elodea nuttallii* (Hoffmann *et al.*, 2013). A dense hessian material and coconut fibre was used to successfully remove three submerged IAAPs (*Ceratophyllum demersum*, *Lagarosiphon major* and *Egeria densa*) within five months (Hofstra *et al.*, 2010). Benthic barriers failed to control *Elodea nuttallii* in flowing waters (Podraza *et al*., 2008).
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	Most of the effort is during the installation of benthic barriers, which may require scuba divers to put the barriers in place and to anchor the barriers within the sediment (de Winton *et al.*, 2013; Gettys *et al.*, 2014). During installation, a reduction in the water level can be used to facilitate the installation of the barriers. If the submerged IAAPs have already built up large stands, a biomass reduction by using other control measures is necessary prior to the installation of benthic barriers. However, in the following, the benthic barriers must be weighed down by using e.g. rocks or sand bags (de Winton *et al.*, 2013), but also a layer of sand or gravel can be used. The matting must be maintained annually to check the position of the barriers, to remove accumulated sediment and to repair (if required). Biodegradable mats must, in some cases, be replaced in order to achieve sustainable long-term control (Hoffmann *et al.*, 2013). Finally, after successful control, plastic or polyethylene barriers must be removed from the habitat, while biodegradable mats can stay in place.
Resources required [1] e.g. cost, staff, equipment etc.	Besides the benthic barriers, scuba divers are required in most situations. De Winton *et al.* (2013) estimated overall costs of $30,000 per ha, excluding any removal of sediments. Considering the initial and follow-up costs, the cost efficiency of this control method must be considered as medium to low.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	The benthic barriers may affect algae and other primary producers, as well as the target aquatic plants. The effects of benthic lining on the sediment and water, native plants, macroinvertebrates and fish depend on the material used as the barrier (de Winton *et al.*, 2013).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Benthic barriers will have an impact on the ecosystem (including macroinvertebrates or benthic fishes), particularly when plastic or polyethylene mattings are used, but these effects can be reduced by using biodegradable matting. Benthic barriers do not have a negative impact on economic activities, and provide a rapid solution in sites where high conflicts of interest occur due to the nuisance growth of *Elodea nuttallii* (e.g. in harbours). Consequently, there is a high acceptability to benthic barriers.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States	Benthic barriers cause relatively high costs per area, but the cost-effectiveness is still high when eradication of *Elodea nuttallii* is achieved. If small infestations (for which benthic barriers are recommended) are not eradicated, the target species will spread, increasing management costs and reducing the likelihood of future eradication.

- the cost of inaction - the cost-effectiveness - the socio-economic aspects	
Level of confidence [2] See guidance section	**High** Benthic barriers were successfully used to control *Elodea nuttallii* and small infestations can be eradicated.

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	**Suction dredging** During suction dredging, a large suction pump uproots the aquatic plants along with parts of the upper sediment layer, and the plants are collected in a fine mesh bag on a floating barge (de Winton *et al.*, 2013). The number of fragments produced during suction dredging is low and most of the fragments are usually sucked up by the pump while the control measures are taking place. Consequently, the likelihood of a spread of the target species by fragments produced during this type of management is low. The method can be used in both shallow and deep water, when operated by divers. The method is suitable for managing small areas (<0.1 ha) (de Winton *et al.*, 2013). Thus, suction dredging is used to eradicate early and small infestations of submerged IAAPs. Due to the translocation of particularly fine and organic sediment, the remaining lake sediment can get less suitable for subsequent weed infestations (de Winton *et al.*, 2013), resulting in effective control for several years (Wells *et al.*, 2000). Suction dredging works best in soft and sandy sediments. Even though the method is described as highly efficient, in some cases hand-weeding is carried out following suction dredging (de Winton *et al.*, 2013; Hussner *et al.*, 2017). During the management of large infestations of weeds, suction dredging can be used as a follow-up technique for remaining small weed stands (de Winton *et al.*, 2013). As the suction dredge is operated by a scuba diver, the method is species-specific and can be used in macrophyte communities with native plants, which will be not affected during dredging.
Effectiveness of measure e.g. has the measure previously worked, failed	Suction dredging has been successfully used to eradicate small infestations, outlier colonies and new incursions of IAAPs such as *Lagarosiphon major* in New Zealand (de Winton *et al.*, 2013). Using suction dredging, a submerged IAAPs was eradicated from a river in Texas (Alexander *et al.*, 2008) and the method was reported as effective for the control of Elodea spec. in Alaska (Etcheverry,

	2012) and *Myriophyllum spicatum* in the US (Boylen *et al.*, 1996).
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	Suction dredging is time-intensive, as an (diving) operators are required and only small areas can be controlled within a certain amount of time. The overall costs are still low, as no maintenance is required. But a monitoring of the effectiveness and duration of control should be carried out on an annual basis (de Winton *et al.*, 2013). In some cases, hand-weeding must follow suction dredging to eradicate remaining individual plants.
Resources required [1] e.g. cost, staff, equipment etc.	Suction-dredging of submerged IAAPs requires a large suction pump and a skilled (diving) operator. For small ponds and infestations near the shore, vehicular access is required, in larger systems a barge must be used instead (de Winton *et al.*, 2013).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Suction dredging is species-specific and thus has only a minor impact on non-targeted plants. During the suction dredging, the turbidity of the water is increased, but less than during other management measures (e.g. Hydro Venturi) (de Winton *et al.*, 2013). The impact on the environment is low, and no impacts on public health are reported.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Suction dredging has a minor impact on recreational activities such as diving, as it increases turbidity within the water column. While control measures are underway, invertebrates within the IAAPs and the upper sediment will be displaced, but direct effects on fish are unlikely as they can use avoidance behaviour to escape.
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 cost of management using suction dredging is moderate, de Winton *et al.* (2013) noted management costs of about 10,000-20,000 NZD per ha. Suction dredging is recommended for small infestations of submerged IAAPs, and inaction will result in spreading of the target species, reducing the likelihood of future eradication and increasing management costs.
Level of confidence [2] See guidance section	**moderate** **Suction dredging was used for the eradication of small infestations of IAAPs, but for Elodea nuttallii no control measures were reported using suction dredging.**

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	**Hydro venturi** The Hydro-Venturi (water jet) system washes the rooted aquatic plants out of the sediment, the

	unrooted plants float up and can be removed from the water surface. The uprooting of plants results in less regrowth in comparison with other methods (i.e. weed cutting). Furthermore, the number of fragments is fewer than when other mechanical control measures such as weed cutting are used (van Valkenburg, 2011; Dorenbosch and Bergsma 2014; Hussner *et al.*, 2017). The method is used best for plants with fragile shoots (like *Elodea* spec.) and in soft sediments. The timing of the management with hydro-venturi is considered essential to guarantee long-term biomass reduction (van Valkenburg *et al.*, 2011). Hydro-venturi can be used in shallow water systems with up to 1.5m in depth (Podraza, 2017).
Effectiveness of measure e.g. has the measure previously worked, failed	Hydro-venturi has been successfully used for the reduction of biomass and abundance of *Cabomba caroliniana* and *Myriophyllum heterophyllum* in a shallow lake in the Netherlands (van Valkenburg, 2011). A single treatment with a modified hand application of hydro-venturi reduced biomass and abundance of *Myriophyllum heterophyllum* by >99% (controlled one year after the management) in a shallow channel system in Düsseldorf (Hussner, unpublished). In the Ruhrstauseen, hydro-venturi was tested for the control of *Elodea nuttallii*, but the results of this test were unsatisfactory (Podraza, 2017). The amount of *Elodea nuttallii* harvested was low, and the management costs higher than with other management methods (weed cutting) (Podraza, 2017).
Effort required e.g. period of time over which measure need to be applied to achieve rapid eradication	The time period needed for successful control depends on the habitat conditions (water depth, sediment type) and density of the IAAPs stands. The use of hand-application is more time consuming, but more species-specific (depending on the skills and experiences of the operator) and more efficient than boat attached hydro-venturi systems, but can be used in shallow water only (<1m) (Hussner unpublished).
Resources required [1] e.g. cost, staff, equipment etc.	The operation of the hydro-venturi system requires 1-2 skilled operators, and the subsequent harvest of the uprooted plant material requires additional workers. The cost of the hydro-venturi system operated by boat is about 1.35-2.05 Euro m^{-2} (depending on sediment structure and other variables), the cost for management using hand-application are about 5 Euro m^{-2} (Hussner unpublished).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Hydro-venturi washes the plants with their root system out of the sediment, and thus the turbidity of the water increases during the application of the control measures. Any organisms within the sediment are dislocated by the water jet. Hydro-venturi is not species-specific like some other selective methods (i.e. hand-weeding), but the effects of other native aquatic plants are reduced when the hand-application is used by a skilled operator.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	As with all other management methods, the control of IAAPs by hydro-venturi has a high level of acceptability by stakeholders and the public, particularly in areas where the nuisance growth of IAAPs prohibits recreational water sport activities. Despite the disturbance of aquatic fauna such as

	macroinvertrebrates, no negative effects on animal welfare are reported.
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 with all management methods, the cost of inaction is usually high and will result in spreading of the target species, reducing the likelihood of future eradication and increasing management costs.
Level of confidence [2] See guidance section	**Moderate** Hydro venturi was successfully used to control submerged IAAPs, but first test to control *Elodea nuttallii* in the reservoirs of the River Ruhr were not successful. More research is needed to improve the success of Hydro-Venturi on the control of IAAPs.

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	**Mowing and cutting of submerged weeds** Mowing and the use of cutter boats is, particularly in Europe, the most common method for the management of submerged IAAPs (Podraza *et al.*, 2008; Zehnsdorf *et al.*, 2015; Hussner *et al.*, 2017). Cutter boats which do not subsequently harvest the cut biomass are relatively cheap, but are less common than methods which cut/mow and harvest the plant material (Gettys *et al.*, 2014; Hussner *et al.*, 2017). The cutting depth is often limited to a maximum of 2m (Podraza *et al.*, 2008; Hussner *et al.*, 2017), but some cutter/harvesters in the US can cut in up to 5m in depth (Hussner *et al.*, 2017). Due to the rapid growth of almost all IAAPs, the plants usually grow back to the water surface in few weeks, depending on climatic conditions and cutting depth (Podraza *et al.*, 2008; Hussner *et al.*, 2017). Consequently, repeated mowing measures are required to reach an acceptable level of control over time (Podraza *et al.*, 2008). Repeated mowing can deplete the reserves in roots and rhizomes, which may result in a lower stature of IAAPs stands and may slow their spread (de Winton *et al.*, 2013). Another method of cutting is using a V-blade, which is pulled through the water. Contrary to mowing with a boat, the cutting with V-blades is less restricted by water depth and cut the plants

	on or just below the sediment surface (de Haan *et al.* 2012). The up-floating cut plant material is subsequently either pushed to the shores and dumped, or harvested from the water surface (Hussner *et al.*, 2017).
Effectiveness of measure e.g. has the measure previously worked, failed	Weed cutting and mowing are only able to control plants by reducing the biomass, but the eradication of a specific species cannot be achieved by this method (except in control programs, where various methods are combined) (Podraza *et al.*, 2008; de Winton *et al.*, 2013; Hussner *et al.*, 2017). Mowing has been used for >10 years to control *Elodea nuttallii* in reservoirs of the River Ruhr to allow for recreational activities (Podraza *et al.*, 2008; Podraza, 2017). However, this long-term mowing programme did not result in a significant decrease of *Elodea nuttallii* biomass. In addition, mowing and cutting produces large numbers of plant fragments, which can lead to an even faster spread of the target species (Anderson, 1998).
Effort required e.g. period of time over which measure need to be applied to have results	All weed cutting measures must be repeated up to several times within a year to receive a significant reduction in biomass of the target species.
Resources required [1] e.g. cost, staff, equipment etc.	Mowing boats and harvesters are required. Podraza (2017) calculated the costs of mowing and harvesting *Elodea nuttallii* at 2,500 Euro per day (for 0.5ha area), summing up to about 2 Million Euros for the management of *Elodea nuttallii* in Lake Baldeneysee only (264 ha) (Podraza, 2007). Removing a narrow strip of *E nuttalii* for navigation in Lower Lough Erne, N. Ireland in 2010 was costed at 91,000 sterling; this included costs for weed harvesting and disposal (P Treacy, Waterways Ireland, Pers. Comm.). In some cases, high contents of contaminants such as trace metals within the harvested biomass can increase the disposal costs (which is the fact for all management efforts, when biomass is harvested; Hussner *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.	Mowing and cutting is not species specific, and species with different growth forms, e.g. plants with floating leaves like Nymphaea spec., might be more affected by these management measures than submerged plants like *Elodea nuttallii*. Harvesting large amounts of biomass reduces the nutrient pool of aquatic systems (which is true for all management methods which remove biomass).
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	The public perception of mowing and cutting is positive, as this is usually carried out, when large weed beds prohibit the recreational use of water bodies. Navigation of Lough Erne, during high weed infestation would not be possible without harvesting and the pressure for weed removal came from leisure craft users.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States	Mowing and cutting have not been documented as providing long-term effects in biomass reduction for *Elodea nuttallii*. Furthermore, the large number of fragments produced can facilitate the spread of the species. Floating barriers should be used to prevent the unintended spread of the species (Ref. Alaska). The cost-effectiveness of mowing and cutting are considered to be low, but

- the cost of inaction - the cost-effectiveness - the socio-economic aspects	still mowing and cutting is considered as the "last option" when *Elodea nuttallii* becomes a nuisance and interferes with recreational water sport activities.
Level of confidence [2] See guidance section	**High** Weed cutting is the most widely used method to control *Elodea nuttallii* in Europe. There are no reports that cutting leads to a long-term sustainable control of *Elodea nuttallii*.

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	**Water level drawdown** Water-level drawdown can be used as a management tool in those waters in which the water level can be manipulated, e.g. ponds and reservoirs (de Winton *et al.*, 2013; Gettys *et al.*, 2014; Hussner *et al.*, 2017). Submerged aquatic plants usually inhabit the shallow zones of water bodies, and thus these areas can be managed by water level drawdown, while most parts of the habitat are not affected (de Winton *et al.*, 2013). During drawdown, plants are exposed to winter frost or to high summer temperatures, full sunlight and dryness, which are intended to kill the plants. Turions and other non-vegetative propagules can survive even several months of water level drawdown (Gettys *et al.* 2014; Hussner *et al.*, 2017). Overall, submerged plant species respond differently to drawdowns, and while some species can be controlled, others show rapid regrowth after the water reaches the previous water level. In particular, minor or short-term water level drawdowns are not likely to result in a significant decrease or eradication of a species (de Winton *et al.*, 2013). For eradication of submerged species, water level drawdown must be applied for several months, and the sediment must be dried out or frozen at the depths at which vegetative and non-vegetative propagules of the target species are located (de Winton *et al.*, 2013). Water-level drawdown can be used in combination with other methods, e.g. biomass harvest (Hussner *et al.*, 2017).

Effectiveness of measure e.g. has the measure previously worked, failed	Water-level drawdown is used for the effective control of submerged IAAPs in the US (Gettys *et al.*, 2014), but in France, no substantial decrease was found of *Elodea nuttallii* one year after a water level drawdown in a channel during summer (Barrat-Segretain and Cellot, 2007). This might be caused by moist areas being maintained beneath a desiccated mat of plants, where *Elodea nuttallii* might have withstood the water-level drawdown, and where it showed a rapid regrowth after the end of the drawdown period (Barrat-Segretain and Cellot, 2007).
Effort required e.g. period of time over which measure need to be applied to have results	A water level drawdown must be applied for several months and should be carried out during winter (and frost) or high summer to achieve the best result (de Winton *et al.*, 2013; Hussner *et al.*, 2017).
Resources required [1] e.g. cost, staff, equipment etc.	A drawdown in water level does not result in large costs, unless the reservoir is used as a drinking water reservoir or hydropower production. Water level drawdown can only be carried out in waters in which the water level can be actively manipulated, e.g. in reservoirs or artificial ponds (de Winton *et al.*, 2013; Gettys *et al.*, 2014).
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	A water level drawdown will affect the whole macrophyte community and the negative impacts on the species may be different due to the different response of plants to this control measure. Moreover, macroinvertebrates may be affected by the water level drawdown when the sediment is freezing or drying. The availability of water might be restricted where the water body is used as a drinking water reservoir.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Water-level drawdowns might affect the human use of water bodies. As mentioned above, macroinvertebrates might be affected, which will affect animals using macroinvertebrates as food source.
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 cost of water-level drawdown differs between water bodies. In drinking water reservoirs, a drawdown in the water level for several months, especially during summer, may affect the availability of drinking water to humans. However, as for all management methods, the cost of inaction are usually high and will result in spreading of the target species, reducing the likelihood of future eradication and increasing the management costs.
Level of confidence [2] See guidance section	**Moderate** Water level drawdown must be carried out for a given period of time during summer or winter, to allow either the complete dry out or freezing of the sediment to achieve a remarkable control.

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	**Biological control** Biological control is the control of a target species by using a biocontrol agent, which reduces the growth or reproductive capacity of the target species (Cuda *et al.*, 2008). The term biocontrol covers various types of biocontrol, including (i) classical biocontrol and augmentive biocontrol, (ii) inundative biocontrol and (iii) the use of generalist herbivores (Hussner *et al.*, 2017). For classical biological control, a biocontrol agent (usually insects) is collected from its native range and introduced for biocontrol into a new range, in which the target species occurs (van Driesche *et al.*, 2010). Prior to the release, a host-specifity test is carried out to ensure that no host shift will occur. A lot of successful examples of classical biocontrol are from aquatic systems, but all of them were carried out on floating or emergent aquatic plant species. The control of submerged aquatic plants, like *Elodea nuttallii*, is considered to be much more difficult (Schmitz and Schardt 2015). The inundative biocontrol with mycoherbicides (fungal pathogens) is a technique which has not been successfully applied in the field yet (Hussner *et al.*, 2017). For *Elodea nuttallii*, no candidates for the inundative biocontrol are reported (Hussner *et al.*, 2017). Generalist herbivores includes both non-native species, which were introduced with the aim of controlling aquatic weeds (e.g. grass carps), or native herbivores, which have a broad host range and feed on alien aquatic plants as well (Hussner *et al.*, 2017). For *Elodea nuttallii*, grass carps (*Ctenopharyngodon idella*) and rudds (*Scardinius erythrophthalmus*) were used as control agents (Hussner *et al.*, 2017; Podraza *et al.*, 2008). However, the success of generalist herbivores such as grass carp depends on stocking densities and the palatability of the target plant species (Hussner *et al.* ,2017). *Elodea nuttallii* is considered to be moderately palatable (Zehnsdorf *et al.*, 2015). It should be borne in mind that the release of macro-organisms as biological control agents is currently not regulated at EU level. Nevertheless national/regional laws are to be respected. Before any release of an alien species as a biological control agent an appropriate risk assessment should be made.
Effectiveness of measure e.g. has the measure previously worked, failed	Grass carp were stocked in several European lakes to control *Elodea nuttallii*, but in many cases this did not result in an eradication of *Elodea nuttallii* (Hussner pers. observations). This is most likely because of the only moderate palatability of *Elodea nuttallii* for grass carp. Furthermore, stocking

	grass carp (which is another invasive species) often results in a decrease of all plant species in the water, with different levels of impact on plant species depending on their palatability (Dibble and Kovalenko 2009; Zehnsdorf *et al.*, 2015; Hussner, pers. observations). Rudds were found feeding on the apical tips of *Elodea nuttallii*, but this did not have a remarkable effect on growth and biomass production of *Elodea nuttallii* in the reservoirs of the River Ruhr (Podraza *et al.*, 2008).
Effort required e.g. period of time over which measure need to be applied to have results	For *Elodea nuttallii*, no classical or inundative control agents are known. Grass carp must be stocked in appropriate quantities (Dibble and Kovalenko, 2009) for several years to prevent any regrowth from vegetative means in the sediment.
Resources required [1] e.g. cost, staff, equipment etc.	The cost of grass carp depends on stocking densities. After successful eradication, grass carp must be removed from the water to allow for the restoration of native plant communities, which is in most cases the most cost-intensive part of this kind of IAAP management (Hussner *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.	Grass carp consume all kind of aquatic plants, so impacts on native plants are likely to be high. The disappearance of submerged aquatic plants will cause a shift to a phytoplankton-dominated state in the ecosystem, with increased turbidity.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	Stocking of grass carp and the effects described above may reduce the acceptability to stakeholders, as turbid waters are less attractive for recreational activities (e.g. swimming and diving). The disappearance of aquatic vegetation may affect waterbirds, which use aquatic plants and associated macroinvertebrates as food.
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 cost-effectiveness is often considered as high for grass carp, if only the costs of stocking are considered. But the follow-up costs make stocking of grass carp as a management strategy expensive. The costs can be reduced in water bodies where water-level drawdown to remove the grass carp is feasible.
Level of confidence [2] See guidance section	**Moderate** No classical biological control agents are known for *Elodea nuttallii*. Grass carps are widely used to control submerged IAAPs like *Elodea nuttallii*, but are not species specific.

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	**Herbicides** Herbicides, in general terms, can be used to control aquatic plants in various types of water bodies, including lakes, channels, irrigation systems, and ponds (de Winton *et al.*, 2013; Gettys *et al.*, 2014; Hussner *et al.*, 2017). Herbicides are usually not species specific, but selectivity can be achieved by choosing between different types of application method, the right concentration and the exposure time (Getsinger *et al.*, 1997; 2008; 2014; Netherland, 2004). Herbicide treatment significantly reduces the biomass of IAAPs and can result in the eradication of a target species (de Winton *et al.*, 2013; Champion and Wells, 2014; Hussner et al,. 2014). Hussner *et al.*, 2017). There are a variety of herbicides which have been tested and subsequently used for the control of IAAPs, but none of them are currently approved for the use in aquatic habitats. 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	For *Elodea nuttallii*, no herbicides have been tested and used for management purposes (Hussner *et al.*, 2017).
Effort required e.g. period of time over which measure need to be applied to have results	None known, as no herbicides have been used for the control of *Elodea nuttallii* yet.
Resources required [1] e.g. cost, staff, equipment etc.	None known.
Side effects (incl. potential) i.e. positive or negative side effects of the measure on public health, environment, non-targeted species, etc.	Herbicides might affect both IAAPs and native aquatic plants. Additionally, negative effects on aquatic fauna seems likely.
Acceptability to stakeholders e.g. impacted economic activities, animal welfare considerations, public perception, etc.	None known.
Additional cost information [1] When not already included above, or in the species Risk Assessment. - implementation cost for Member States	None known.

- the cost of inaction - the cost-effectiveness - the socio-economic aspects	
Level of confidence [2] See guidance section	**Low.** No herbicides have so far been used to control *Elodea nuttallii*. For other submerged aquatic plants, herbicides are considered as a valuable tool to control or eradicate submerged IAAPs.

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<u>Notes</u>

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

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

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

3. Citations and bibliography. The APA formatting style for citing references in the text and in the bibliography is used.
e.g. Peer review papers will be written as follows:
In text citation: (Author and Author, Year)
In bibliography: Author, A. A., and Author, B. B. (Publication Year). Article title. *Periodical Title*, Volume(Issue), pp.-pp.
(see http://www.waikato.ac.nz/library/study/referencing/styles/apa)