MARIE PATINET - ETIENNE BRANQUART - ARNAUD MONTY

Lagarosiphon major

Species description

Curly waterweed (*Lagarosiphon major*) is a perennial, submerged aquatic plant native to South Africa. The species was introduced to Europe, including Belgium, through the aquarium industry as a popular oxygenating plant for aquariums. The first records of the curly waterweed's presence in the environment in Belgium date back to 1993. Disposal of aquarium waste in water systems is probably at the origin of its escape in the wild. Today, the plant represents a problematic aquatic invasive species in many countries worldwide and is now listed as IAS of Union concern under the EU Regulation No 1143/2014. The species can easily be confused with other non-native plant species such as *Elodea nuttallii*. Its submerged form also makes the plant hardly detectable. As a result, its presence on the Belgian territory probably remains underestimated.

Fig 1. *Lagarosiphon major*. Photo: Q-Bank

Guide de gestion complet en version française

Volledige beheergids in Nederlandse versie

Lagarosiphon major

Curly waterweed is mostly found in clear stagnant or slow-moving water systems such as freshwater lakes, large ponds and canals. The species thrives in water systems with sandy bottoms and high light intensity. As a highly competitive invasive species, the plant has diverse environmental, social and economic impacts. Curly waterweed, which can grow several meters long, can form dense and monospecific beds and colonise the whole water column. This has detrimental impacts on the ecosystem and biodiversity, including oxygen depletion, higher pH levels, complete light exclusion, and displacement of native plant community. Social and economic effects include restriction on recreational activities (angling, boating), swimming hazards, increased flooding risks and associated management costs.

Biological characteristics, reproduction and spread

In most of its introduced range, including Belgium, curly waterweed grows in the spring from rhizomes and shoots. It produces flowers and large masses of stems during summer. The species then becomes dormant in the winter months, but cold temperatures do not restrain its invasion.

Curly waterweed is a dioecious species. Its reproduction in western Europe is exclusively vegetative via female plants only. When the plant breaks into fragments, whether naturally or due to human activity, those small fragments can form a new plant and, therefore, a new population, away from the initial invaded area. The spread of this invasive weed can occur through fragments attached to boats or other water equipment. Fragments can remain viable outside water due to their high tolerance to desiccation. Those high dispersal abilities highlight the importance of the implementation of effective management measures.

Fig 2. Curly waterweed forming dense monospecific beds at the water surface. Photo : Saxifraga-Peter Meininger

References

Bickel, T.O. (2012) *Lagarosiphon major* (Ridley) Moss ex Wager (curly water weed). In: Francis, R. A. (ed.) *Handbook of global freshwater invasive species.* United Kingdom, Earthscan, pp. 79-91.

Branquart, E. *et al.* (2013) *Invasive alien species in Belgium*: Lagarosiphon major. http://ias.biodiversity.be/species/show/68 [Accessed: 5th October 2022].

Caffrey, J., Evers, S. and Moran, H. (2009) *Research and control programme for* Lagarosiphon major *in Lough Corrib 2008.* Central Fisheries Board.

Caffrey, J. *et al.* (2010) A novel approach to aquatic weed control and habitat restoration using biodegradable jute matting. *Aquatic Invasions,* 5(2), 123–129.

Caffrey, J. *et al.* (2012) Management of *Lagarosiphon Major* (Ridley) Moss in Lough Corrib—A Review. *Biology & Environment: Proceedings of the Royal Irish Academy*, 111(3), 205–212.

CAISIE (2013) *Control of aquatic invasive species and restoration of natural communities in Ireland – CAISIE Layman's Report*. Life CAISIE Project and Inland Fisheries Ireland.

Hussner, A. (2019) *Information on measures and related costs in relation to the species included on the Union list -* Lagarosiphon major. IUCN.

General considerations about management

A range of management options have successfully been used to control or eradicate this species. Achieving local eradication of both small and large infestations of curly waterweed is considered feasible due to highly effective and promising management methods, such as benthic jute matting (light deprivation). This management measure has probably become one of the dominant techniques for the management of curly waterweed as it enables the eradication of large populations and provides numerous advantages over other commonly used methods. However, curly waterweed exhibits a wide range of variability in its development and phenology, which can pose challenges in determining the optimal timing for effective management. The eradication feasibility of this species must, therefore, always be assessed on a case-by-case basis, considering site specificities, and be thoroughly discussed within the management team.

Due to the species' ability to reproduce vegetatively by fragmentation, precautionary measures must be put in place prior to management to prevent fragment spread within the managed area or to other water systems. Managed areas are, therefore, isolated by physical barriers.

The harvested plant material must be safely disposed of away from water systems. Burial, drying (in the sun), or burning are suitable ways of disposal. Material that has been in contact with the plant (e.g. diving equipment, clothing) should be checked, cleaned and dried before being taken to another site. It is also recommended to restrict public access to the managed area to isolate the infestations as much as possible and limit the risk of spread.

Managed and downstream sites must remain under enhanced surveillance for a 5-year period after the implementation of the last treatment.

Invasive Species Specialist Group. (2022). *Global invasive species database* – Lagarosiphon major. http://www.iucngisd.org/gisd/speciesname/Lagarosiphon+major [Accessed: 5th October 2022].

Lafontaine, R., Beudels-Jamar, R. and Robert, H. (2013) *Risk analysis of the Curly Waterweed* Lagarosiphon major *(Ridley) Moss*. Royal Belgian Institute of Natural Sciences.

Matthews, J. *et al.* (2012) *Risk analysis of non-native Curly Waterweed* (Lagarosiphon major) *in the Netherlands*. Radboud University Nijmegen, Institute for Water and Wetland Research, Department of Environmental Sciences, FLORON & Roelf Pot Research and Consultancy.

Mikulyuk, A. and Nault, M. (2022) Lagarosiphon major *(African elodea)*, *CABI Compendium*. https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.30548 [Accessed: 5th October 2022].

Redekop, P., Hofstra, D. and Hussner, A. (2016) *Elodea canadensis* shows a higher dispersal capacity via fragmentation than *Egeria densa* and *Lagarosiphon major*. *Aquatic Botany*, 130, 45–49.

Manual removal

- v Local eradication can be achieved
- v Manual removal is highly selective and will have minimal disturbance and impact on ecosystems and other organisms
- x The method is only suitable for small and early-detected infestations
- x There is a risk to create and spread fragments to uninvaded areas
- x Scuba diving requires qualified operators

Method description

The principle is to remove the whole plant from the ecosystem. Plants are pulled out by the roots by scuba divers or snorkelers (deep water) or by agents wading (shallow water). Operators must pay great attention not to fragment the plants. This method is implemented in autumn, when the plant is more prostrate, in recently invaded sites or areas with low vegetative abundance. The managed site is surveyed 8 weeks after the initial manual removal to check for regrowth or plants that may have been overlooked. This management method generally needs to be frequently repeated over a 3 to 5-year period.

Material

Management: Diving equipment. Buoys to demarcate the managed area

Transport and stocking*:* Buckets or mesh bags

Precautionary measures*:* Hand net, floating booms, retention nets or bubble curtains

References

Bellaud, M. D. (2009) Cultural and physical control of aquatic weeds. In: Gettys, L.A., Haller, W. and Bellaud, M. (eds.) *Biology and control of aquatic plants, a best management practices handbook.* Aquatic Ecosystem Restoration Foundation, Georgia, pp 139-132.

Caffrey, J., Evers, S. and Moran, H. (2009) *Research and control programme for* Lagarosiphon major *in Lough Corrib 2008.* Central Fisheries Board.

De Winton, M. and Clayton, J. (2016) *A ten year Lagarosiphon management plan for lake Wanaka: 2016-2025.* National Institute of Water & Atmospheric Research.

Hussner, A. (2019) *Information on measures and related costs in relation to the species included on the Union list -* Lagarosiphon major. IUCN.

Morrissey, E. *et al.* (2020) Lagarosiphon major *research on Lough Corrib. Inland* Fisheries Ireland.

Mechanical removal: floating machines

- v Short-term control can be expected
- v Mechanical removal is suitable for large scale infestations
- x Eradication is unlikely or hardly achievable
- x Mechanical removal can create plant fragments with the risk to spread the species to uninvaded areas and other parts of the managed water system
- x Mechanical removal can affect fish and macroinvertebrates

Method description

The principle is to mechanically remove parts of the plant or, depending on the type of machinery, the entire plant from the ecosystem. Plants are cut by boats equipped with a cutting mechanism, to a limited depth of 2m. V-blades can also be pulled along the bottom of the water body to uproot the plants. Mechanical control is preferably carried out multiple times every year during spring and summer, when the plant is visible. This method is usually combined with other measures, such as the placement of benthic covers, to enhance its effectiveness.

Acting in a similar way to the v-blades, the harkboot, a boat equipped with a large rake on one side and another rake with inserted mesh on the other, could also be tested for this species. The large rake scrapes up the bottom of the water body to a depth of 10 to 15 cm while the rake with inserted mesh is used to collect the uprooted plant material and discharge it on the bank. The type of rake tines must be chosen accordingly with the type of substrate and the targeted species. For the management of curly waterweed, coarse tines will be preferred in clay beds while small tines will be favoured for sand beds. As different boat dimensions are available, this method can be applied for large or small infestations in deep or shallow waters (at least 0.6 m deep). If the method is implemented in slow-moving waters, it is recommended to work accordingly with the direction of the current to prevent re-infestation of cleaned-up areas to occur.

References

Bateau-rateau (n.d.) *Arrachage de plantes aquatiques indésirables avec les racines - Plantes exotiques – Nénuphar jaune – et plein d'autres espèces, bateau-rateau.* https://www.bateau-rateau.fr/ [Accessed: 7th February 2023].

Hussner, A. (2019) *Information on measures and related costs in relation to the species included on the Union list -* Lagarosiphon major. IUCN.

Lagler, F. (2021) *Plante invasive du canal : de la Hollande émerge une solution.* https://jhm.fr/plante-invasive-du-canal-de-la-hollande-emerge-une-solution/ [Accessed: 7th February 2023].

Morrissey, E. *et al.* (2020) Lagarosiphon major *research on Lough Corrib.* Inland Fisheries Ireland.

Pot, R. (2020) *Monitoring exoten Oranjekanaal 2020.* Roelf Pot onderzoek-en adviesbureau Pandijk.

Pot, R. (2022) *Monitoring exoten Oranjekanaal 2021.* Roelf Pot onderzoek-en adviesbureau Pandijk.

Similarly, if mechanical removal is implemented in stagnant waters, the direction of the wind or the presence of hydraulic infrastructures, which may influence current, must be considered. As the weather and wind direction can change throughout the day, the working method must be adjusted accordingly. The harkboot must be stopped when hypoxia is observed by the operators. Mechanical removal is immediately followed by manual removal of plants that were inaccessible to the machines (e.g. plants rooted near the bank or obstacles).Remaining drifting plant fragments are also removed. Repeated mechanical removal is often necessary (at least once a year) over a few years (4 years) to notice a drastic reduction in population density. Regular site surveys must be implemented. Once good level of control is achieved and the infestations is limited, manual aftercare is implemented to remove regrowth.

Material

Management: The adequate boat

Transport and stocking: Buckets and trucks

Precautionary measures: Hand net, retention nets. A floating net with lead-line must also be placed at the downstream part of managed area and remain in place for at least 5 days following the operation.

Fig 3. Example of aquatic weed harvester being used for the management of invasive aquatic plant species. Photo : Wassersalat

Light deprivation: benthic jute matting

- v Local eradication or really good control can be achieved within a few months
- v The method is suitable for both limited and large invaded areas/water systems
- v The material is biodegradable, thus does not require to be removed (eco-friendly and no removal costs)
- v The jute enables native plants to grow through it which allows vegetation to reestablish. It also enables gas to escape
- x This method is limited to stagnant waters
- x The placement of jute matting might be impracticable or impossible in areas with obstacles
- x The method is likely to be detrimental to benthic organisms and affect fish spawning

Method description

The principle is to install bottom covers that both compress vegetation and exclude sunlight, causing the death of the plants. Jute matting, a natural and biodegradable vegetable fiber, is placed by divers on the bottom of the water body. For large curly waterweed populations in deep waters, long strips of jute are deployed from a boat on the water surface and rapidly sink to the bottom. For smaller populations, sheets are manually placed on the weed bed by divers. It is really important that no light reaches the plants from any adjacent area, gaps or at the edges of the sheeting. Divers or operators must ensure the adequate placement of the matting and that strips overlap correctly. The use of large continuous pieces of sheeting is therefore recommended whenever possible. Weights are attached on the side of the jute to secure the covers to the bottom and help with accurate placement. Jute is never to be removed as it disintegrates after 1 or 2 years. Eradication is, however, achieved after 4 to 7 months. Benthic covers are placed when the plants are prostrate. If not possible, mechanical cutting can be implemented prior to the placement of the jute to reduce the biomass and facilitate the fixing of the material to the bottom. If cutting is implemented, operators must ensure that no fragment remains as there is a high risk that new plants will grow on top of the matting. Once the jute disintegrated, inspections and manual removal of remaining plants or any plant regrowth are conducted until the complete disappearance of the species.

References

Caffrey, J., Evers, S. and Moran, H. (2009) *Research and control programme for* Lagarosiphon major *in Lough Corrib 2008.* Central Fisheries Board.

Caffrey, J. *et al.* (2010) A novel approach to aquatic weed control and habitat restoration using biodegradable jute matting. *Aquatic Invasions,* 5(2), 123–129.

Caffrey, J. *et al.* (2012) Management of *Lagarosiphon Major* (Ridley) Moss in Lough Corrib—A Review. *Biology & Environment: Proceedings of the Royal Irish Academy,* 111(3), 205–212.

Hussner, A. (2019) *Information on measures and related costs in relation to the species included on the Union list -* Lagarosiphon major. IUCN.

Madsen, J.D. (2000) *Advantages and Disadvantages of Aquatic Plant Management Techniques. U.S.* Army Engineer Research and Development Center.

Morrissey, E. et al. (2020) Lagarosiphon major *research on Lough Corrib.* Inland Fisheries Ireland.

Material

Management: The adequate quantity of jute matting rolls. It is important to ensure that the plant does not grow through the fabric's holes. Jute textile 200 g.m^{-2} is recommended. Weights, rocks, concrete blocks or sandbags. Boats and buoys to demarcate the managed area. Harvesters with sickle-bar cutting blades are used for mechanical cutting.

Non-biodegradable material such as woven synthetics, black plastic or polyethylene sheets has commonly been used as benthic covers for the management of fanwort. However, this type of material presents many significant disadvantages. For non-permeable material, gases can accumulate and lift the blankets, allowing light to reach the plants. Non-biodegradable material also requires to be removed, which generates additional costs. It also has a greater negative impact on living organisms and the ecosystem.

Precautionary measures: Hand net, floating booms, containment nets or bubble curtains (if mechanical cutting is conducted).

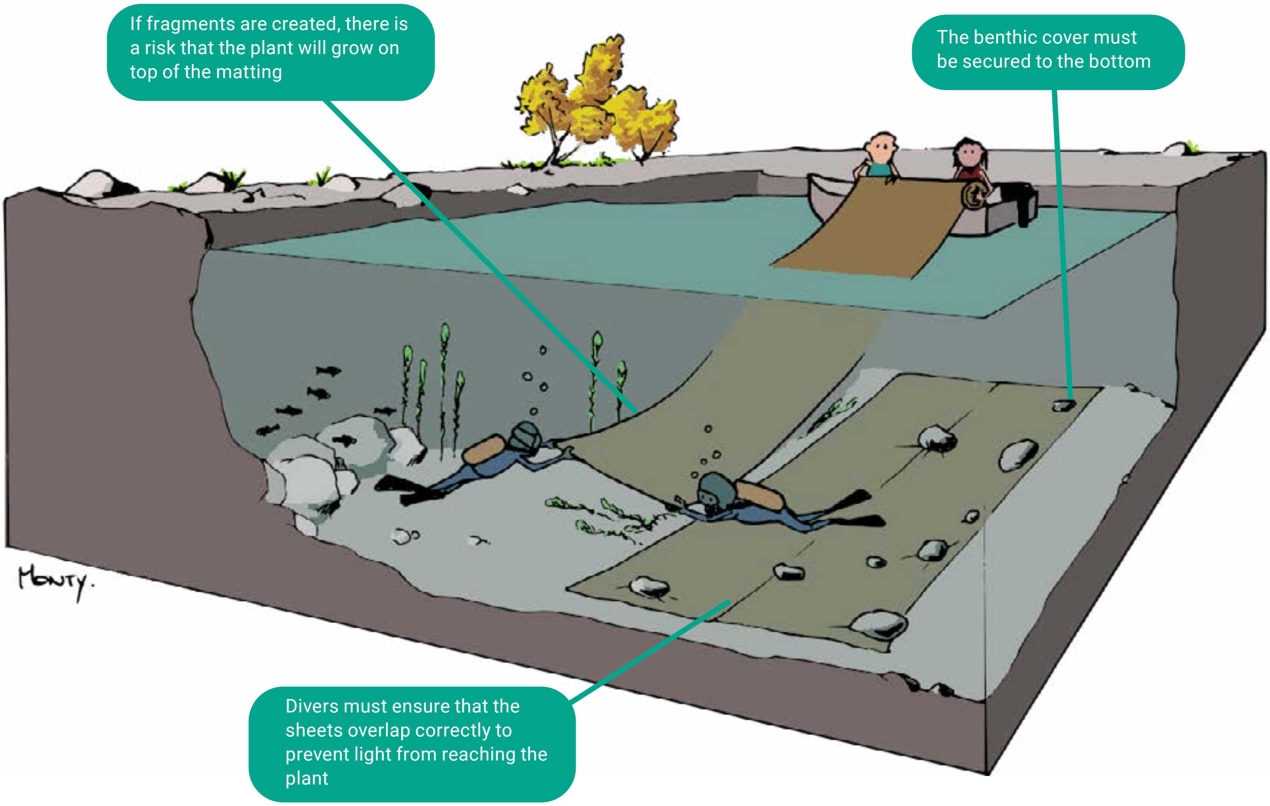

Fig 4. Jute matting application by divers in a deep water body

The impact of management actions on ecosystem services

While the adverse effects of IAS are well-known and provide strong incentives for implementing management actions, the impacts of these management actions on ecosystems and the services they provide are less considered. The matrices are the result of expert assessments of the evolution of relevant ecosystem services (ES) from a highly invaded situation towards a managed situation. ES evolution is considered over 2 given periods of time: 1 year and 5 years after the initiation of management.

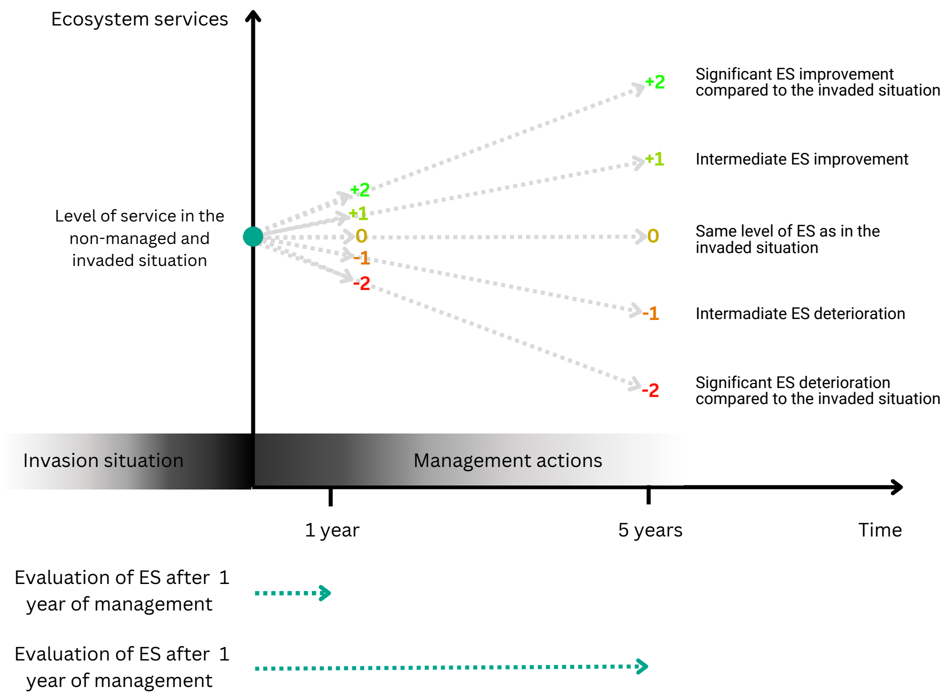

Fig 5. Representation of the survey process

Each matrix displays the average impact scores of management methods on ecosystem services. These scores have been associated to colours to facilitate the visualization of the impacts of every method on every relevant ecosystem service. Green indicates a significant improvement in the ecosystem services (ES) due to management, orange represents no or minimal effect, and red signifies a negative impact of the method on the ES.

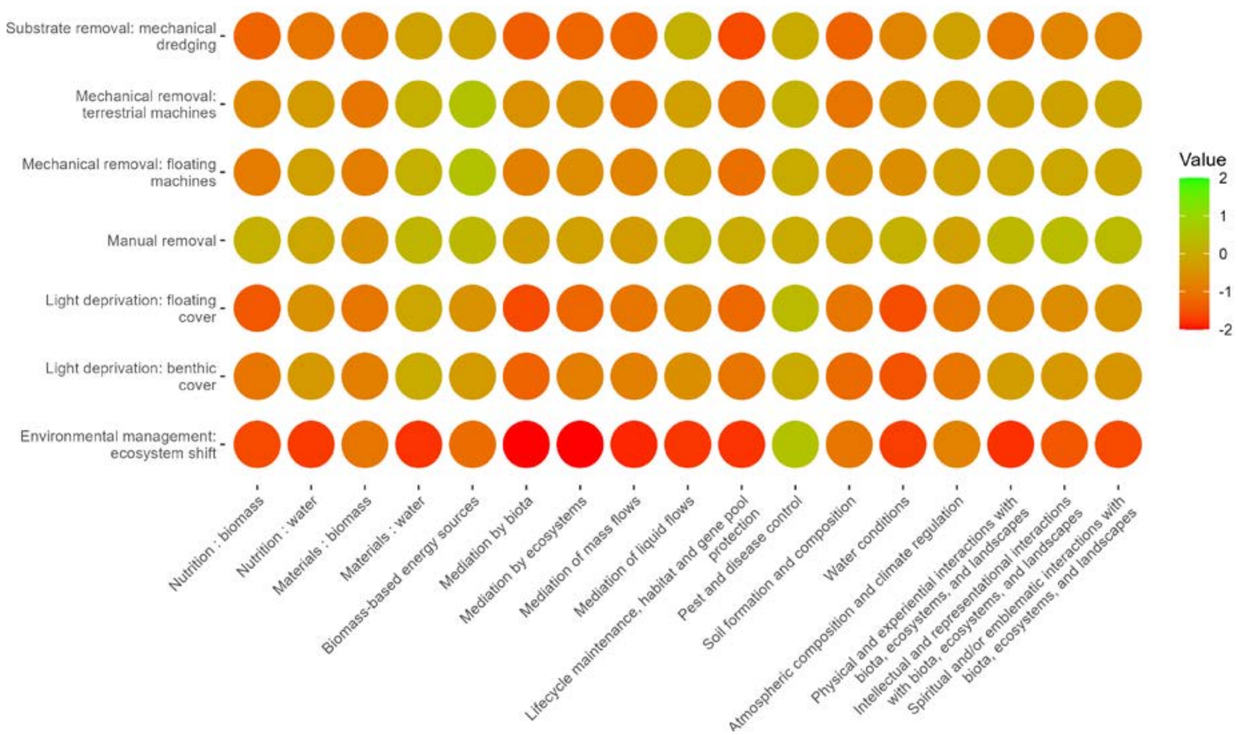

Fig 6. Matrix displaying the impact of management methods for aquatic plant species on ecosystem services after 1 year

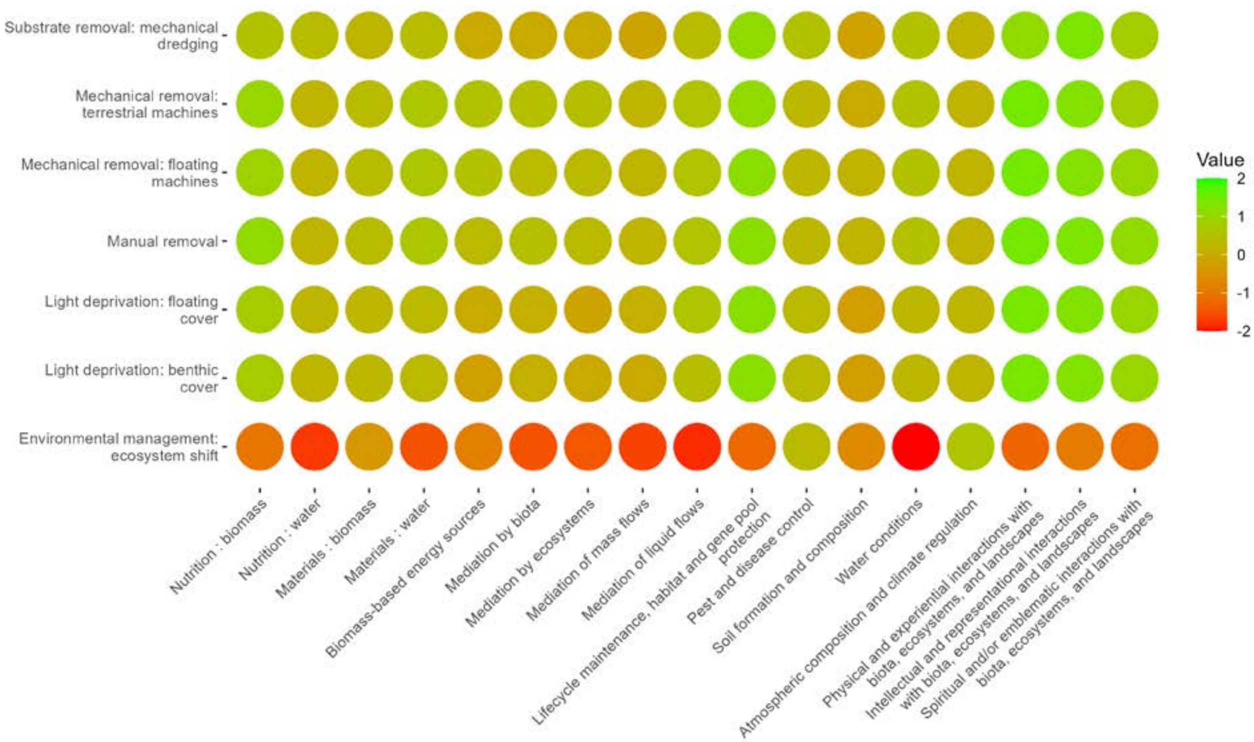

Fig 7. Matrix displaying the impact of management methods for aquatic plant species on ecosystem services after 5 years

LIFE RIPARIAS

Reaching Integrated and Prompt Action in Response to Invasive Alien Species

Citation

Patinet, M., Branquart, E. and Monty, A. (2024). Management fact sheet - *Lagarosiphon major.* LIFE RIPARIAS project, 12p.

www.riparias.be

This project is co-funded by the European Union. Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

RIPARIAS

Reaching Integrated and Prompt Action in Response to Invasive Alien Species

bruxelles environnement leefmilieu brussel .brussels

NATURA 2000

Life Co-funded by the European Union

VLAAMSE MILIEUMAATSCHAPPIJ

INSTITUUT NATUUR- EN BOSONDERZOEK Vlaanderen is wetenschap

AGENTSCHAP NATUUR & BOS

Biodiversity.be

Wallonie service public SPW

LIÈGE université Gembloux Agro-Bio Tech

Dendre Contrat de rivière

CONTRAT DE RIVIERE SENNE

GETTE DYLE CONTRAT RIVIÈRE