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Cabomba caroliniana

Species description

Fanwort (*Cabomba caroliniana*) is a submerged aquatic plant native to South and North America. The species was introduced to Europe, including Belgium, via the aquarium industry as a popular ornamental and oxygenating plant for aquarium. The first record of fanwort's presence in the environment in Belgium dates from early 2000s. Disposal of aquarium waste in water systems is probably at the origin of its escape in the wild. Today, fanwort 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. This species can easily be confused with other plant species including native macrophytes like water-crowfoot. Its distribution on the Belgian territory is probably underestimated

Fig 1. *Cabomba caroliniana.* Photo: Kieft Ben

Guide de gestion complet en version française

Volledige beheergids in Nederlandse versie

Photo: Eric C. Maxwell

Cabomba caroliniana

Fanwort thrives in fresh, stagnant or slow-moving water systems often rich in nutrients such as streams, ditches, ponds, lakes and canals. As a highly competitive invasive species, the plant has diverse environmental, social and economic impacts. Due to its long branching stems, the species can form dense populations and colonise the whole water column. This has significant detrimental impacts on the ecosystem and biodiversity through native plant exclusion, water quality modification, light penetration restriction, etc. Social and economic effects include restriction of recreation (fishing, boating), swimming hazards, water treatment costs and management strategy related costs.

Biological characteristics, reproduction and spread

This invasive weed makes shallow roots in the substrate which limits its distribution to stagnant or slow-moving waters. Fanwort sinks back to the bottom during winter and is therefore undetectable at that period. It then grows rapidly to the surface the next season as the weather gets warmer (around April). In Western Europe, flowers and floating leaves are occasionally produced.

Reproduction in Belgium appears to be exclusively vegetative. Stems are fragile and easily break up when disturbed. Plant fragments can form new plants, and therefore new populations, away from the initial invaded area. Fanwort dispersal notably occurs though water movement or via fragments attached to boats, water equipment and animals. The plant can survive in a free-floating state for 6 to 8 weeks. Stem fragments are, however, highly sensitive to dryness and remain viable for only 24 hours under dry conditions but for weeks under moist soil conditions. Those high dispersal abilities highlight the importance of the implementation of effective management measures.

General considerations about management

A range of management options have successfully been used to control or eradicate this species. Local eradication of fanwort is considered achievable for limited or dense infestations in small water bodies. Eradication of the species remains however more challenging in moving water systems notably due to the complexity to implement effective methods such as light deprivation. As fanwort requires full sun for growth, promoting environmental shading through revegetation with native species can help prevent the (re)establishment of this invasive plant. The fragility of the stems is also a major constraint limiting the efficiency of some operations such as mechanical removal due to incomplete uprooting of plant material. The eradication feasibility of fanwort populations must, therefore, always be assessed on a case by case basis, considering site specificities, and be thoroughly discussed within the management team.

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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 the water and brought to refuse sites. Material that has been in contact with the plant (e.g. waders, clothing) should be checked, cleaned and dried before going 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.

Fig 2. A ditch entirely invaded by fanwort in Belgium. Photo : Provincie Oost-Vlaanderen dienst

Fig 3. Fanwort population restricting light penetration. Photo : Eric Keith

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Manual removal

- v Local eradication can be achieved if carefully implemented in the long-term
- 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 or for small water systems
- x The method is time consuming and labour intensive, particularly in large sites
- x There is a risk to spread fragments to uninvaded areas
- x Scuba diving requires qualified operators

Method description

The principle is to remove the whole plant from the ecosystem without breaking the fragile stems or leaving root fragments in the sediments. Plants are cautiously pulled out by the roots either by operators walking in the water or by scuba divers (e.g. deep or turbid water). Operators must move very carefully through the water to avoid creating plant fragments. It is also strongly recommended to place a net at the downstream part of the managed area. Manual removal can be conducted all year round but might be more suitable in spring, when the plant is visible but still prostrate. It is strongly recommended to repeat the operation shortly after the initial removal, once sediments have settled, to ensure that no plants have been overlooked. This management strategy is conducted and repeated several times every year until no regrowth is found (minimum 3 years). It is also suitable to have people on the bank catching the fragments that would be released.

Material

Management: Waders, diving equipment

Transport and stocking: Buckets or mesh bags, trucks and containers

Precautionary measures: Hand net, floating booms, contain

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Mechanical removal: floating machines

- v Good control can be expected
- v Mechanical removal is suitable for many situations, even well-established populations in deep or shallow waters
- x Eradication is probably unlikely or hardly achievable
- x This method can negatively affect fish communities and ecosystems through oxygen depletion
- x This technique can negatively impact plant communities due to accidental removal of non-target plant species
- x It is an expensive method, especially during the first few years of implementation

Method description

The principle is to mechanically remove the whole plant from the ecosystem. Plants are uprooted by floating machines such as weed conver boats. The harvested plant material can be stocked on board or unloaded on the bank. One concrete example of machines used is the harkboot, a boat equipped with a large rake on one side and another rake with inserted mesh on the other. The large rake scrapes up to 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 fanwort, coarse tines will be preferred in clay beds while small tines will be favoured for peat and sand beds. Mechanical control is preferably implemented a few times per year (up to 4 times) between May and October, when the plant is visible. 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 running waters, it is recommended to work accordingly with the direction of the current to prevent re-infestation of cleaned-up areas to occur. 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 taken into account. As the weather and wind direction can change throughout the day, the working method must be adjusted accordingly.

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The harkboot must be stopped, and management postponed 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 of the population. Regular site surveys must be implemented. Once good level of control is achieved and the infestations limited, manual aftercare is implemented to remove regrowth.

Material

Management: The adequate weed conver 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 the managed area and remain in place for at least 5 days following the operation.

Fig 4. Mechanical removal using floating machines is ususally implemented in large water systems. Photo : Aquarius Systems

Substrate removal: mechanical dredging

- v This is one of the fastest methods to achieve good long-term control
- v This method is suitable for large infestations
- x Local eradication is possible but unlikely
- x This method can only be implemented in sites where the whole area is accessible to the machines
- x Dredging can create vast numbers of plant fragments with the risk to spread the species to uninvaded areas
- x This method can have high negative impacts on aquatic living organisms

Method description

The principle is to remove the bottom sediments contaminated with all parts of the invasive plant such as roots, stems, etc. Excavators equipped with a cleaning bucket thumb are used for excavation at a depth of 20 to 60 cm. This method is always preceded by a water drawdown or a complete drainage (whenever possible) during which care should be taken not to spread plant fragments. The placement of mesh filters at the outlet is therefore necessary. Biofilters must be placed if pumping is required to prevent fragment spread, notably via the sewage system. It is also strongly recommended to place a net at the downstream part of the managed area. Mechanical dredging is preferably conducted in spring, during the growing season. This management method is immediately followed by manual removal to eliminate any remaining plant material. Manual removal is, then, implemented as a follow up measure for minimum 2 years to remove any regrowth.

Material

Management: Excavators equipped with cleaning bucket thumb

Transport and stocking: Buckets or mesh bags, trucks and containers

Precautionary measures: Hand net, floating booms, containment nets, biofilter, sand or mesh filters

References

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Light deprivation: floating cover

v Local eradication or really good control can be achieved within a few months

x The method is suitable for small water bodies or limited invaded areas

x This method is limited to stagnant waters

x The method is not selective and will have high impact on other living organisms, particularly if the whole water body is covered

x Shading alters the physicochemical properties of the water bod

Method description

The principle is to exclude the light or significantly reduce the amount of light reaching the plant to cause its death. A floating opaque sheeting (at least 99% light-blocking) is either placed over the whole pond or over a section of the water body. As fanwort displays a high tolerance to shade, it is important that no light reaches the plants from any adjacent area, gaps or at the edges of the sheeting. Operators must therefore ensure that sheets overlap correctly. The use of large continuous pieces of sheeting is recommended whenever possible. If floating covers are placed over a section of the water body or used to manage edge infestations, side-curtains are fixed to the edges of the blanket to ensure that no light reaches the plants by the sides. The blanket is then attached and secured to the bank. Floating blankets must be placed early in the season (early spring), when the plants are still prostrate, and remain in place for minimum 3 to 4 months. Regular checks and repairs of potential damages that would allow light to pass through must be done. Sheeting removal is immediately followed by an inspection of the managed area to check for any regrowth. If remaining plants or regrowth are found, manual removal is implemented as a follow up measure over 3 consecutive years.

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Material

Management: The adequate quantity of sheeting, blocking at least 99% of the light such as builders' black plastic or pool covers. Rope, cable, star pickets or heavy weights. Side-curtains made of black plastic.

If damages occur to the sheeting, plastic zip ties can be used to join the blankets together. Buoys can also be fixed to the corners of the blanket to delimitate the management area.

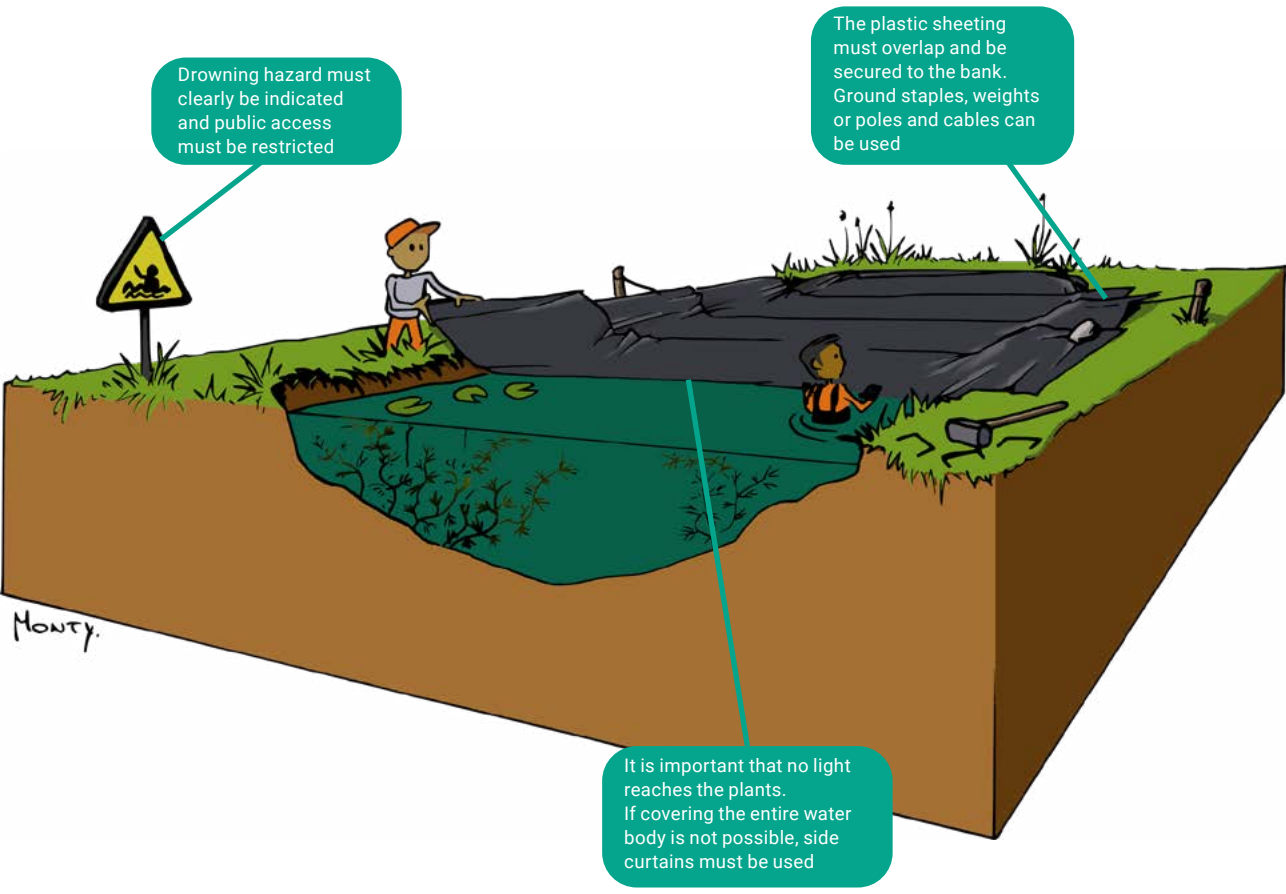

Fig 5. Placement of light-blocking floating covers to create high levels of shade and kill the plant

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
- v The material is solid and 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 the sheeting might be impracticable or impossible due to the presence of obstacles
- x This 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 or operators on the bottom of the water body. For large fanwort populations in deep waters, long strips of jute are deployed from a boat on the water surface which rapidly sink to the bottom. For smaller populations, sheets are manually placed on the weed bed by divers or operators. 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 therefore ensure the adequate placement of the matting and that strips overlap correctly. The use of large continuous pieces of sheeting is recommended whenever possible. The sheets must, then, be secured to the bottom using weights. Benthic covers are placed during winter, when the plants are prostrate, and are never to be removed as jute eventually disintegrates after 1 or 2 years. Eradication is, however, achieved after a few months. Once the jute disintegrated, inspections and manual removal are conducted to remove any plant regrowth, until none is found.

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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 with mesh size 0.5 mm, 300 $g.m^{-2}$, is therefore recommended for fanwort. Weights, rocks, concrete blocks or sandbags. Boat and buoys to demarcate the managed area.

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.

Fig 6. The fabric's holes must be small enough to prevent the plant from growing through the matting. Photo: Marie Patinet

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.

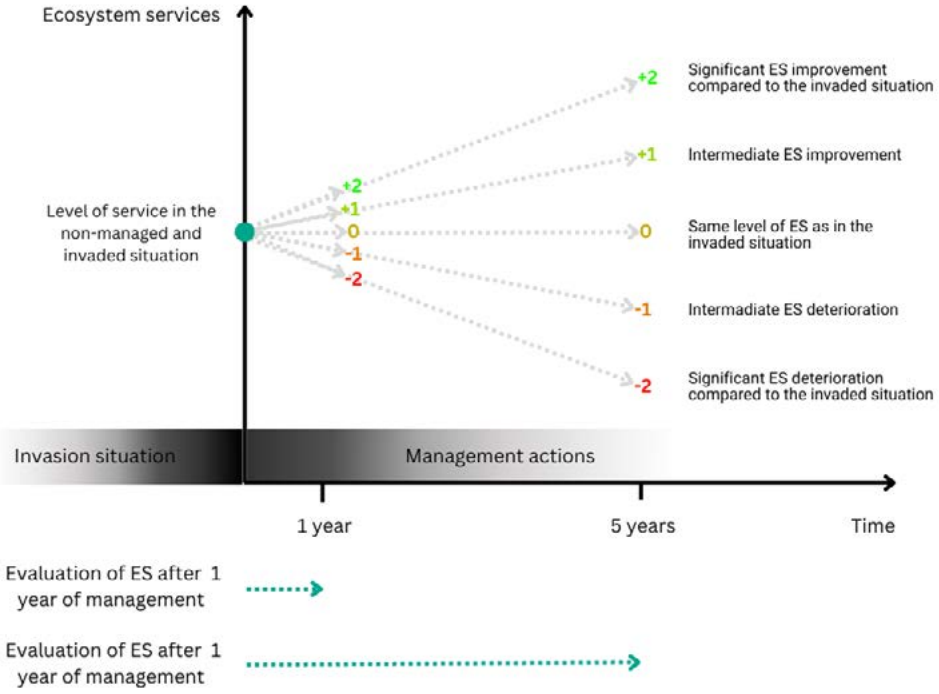

Fig 7. Representation of the survey process

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.

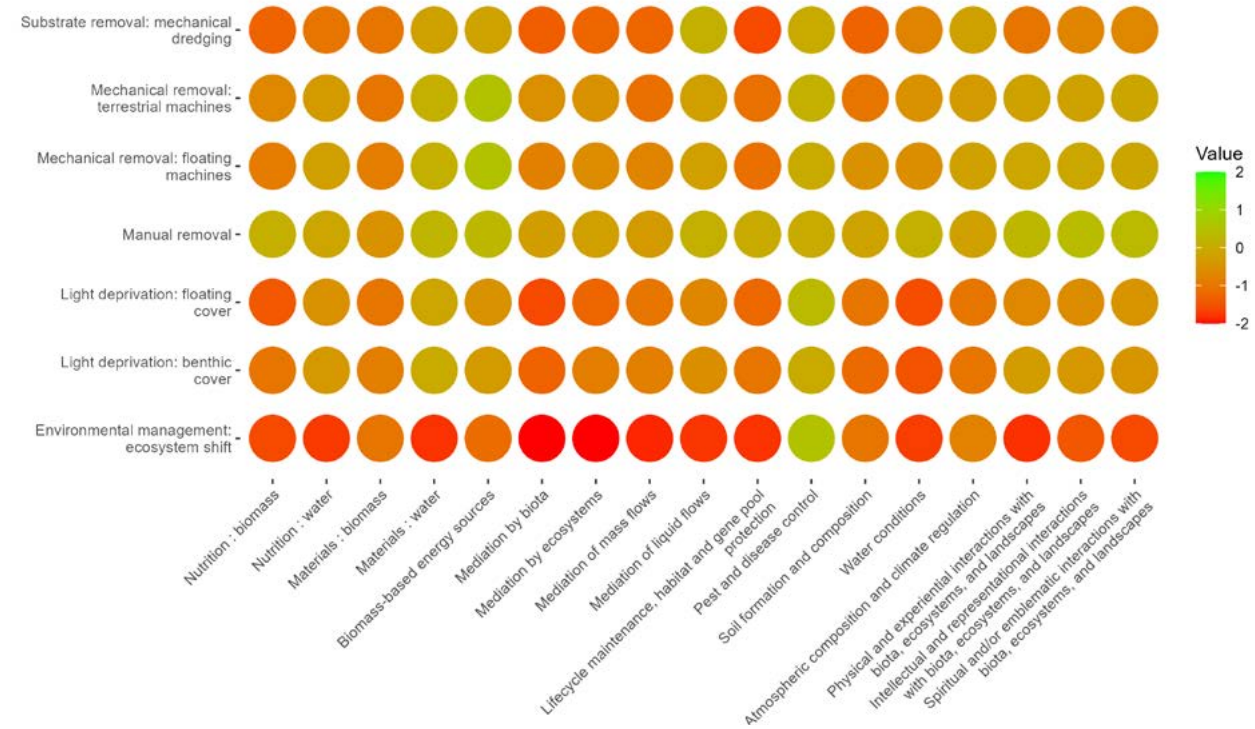

Fig 8. Matrix displaying the impact of management methods for aquatic plant species on ecosystem services after 1 year

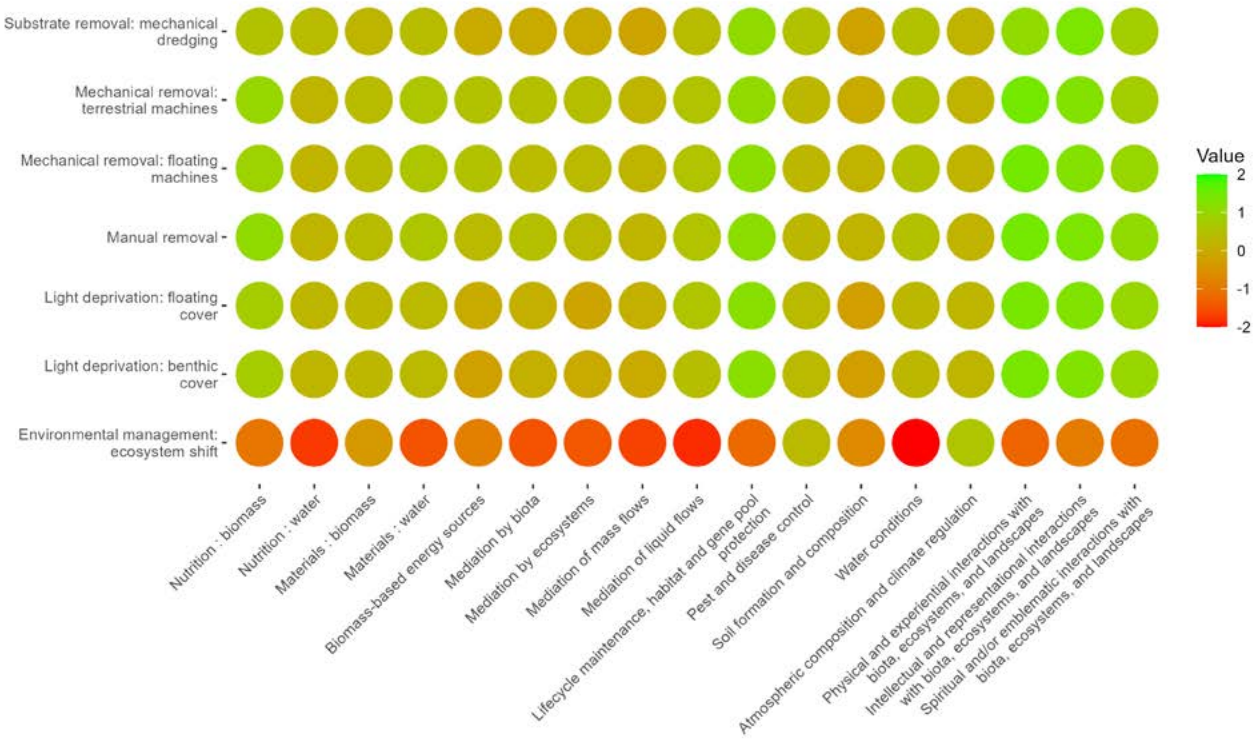

Fig 9. Matrix displaying the impact of management methods for aquatic plant species on ecosystem services after 5 years

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